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Research in Farm Electrification[1]

By Geo. W. Kable[2]

THE YEAR 1930-31 has added new chapters to the story of electricity on the farm. Ninety thousand farmers who last year were carrying lanterns, cranking engines, and using pump handle tactics on the water supply, are now snapping switches, thrilling over a new joy of living, and possibly scratching heads as the additional monthly "letter" comes in interpreting kilowatt-hours in terms of dollars and cents. The agricultural engineers are concerned with all of it from switches to scratches. In this time of experimenting and learning to combine this versatile force, electricity, with the age-old job of living and farming, we are pioneers. On the one hand is a public service which has grown with marvelous rapidity and diversity from the nothingness of forty years ago to be the life impulse of urban industry today; on the other hand is the farm and the home with their established customs and processes based on years of precedent and not easily adaptable to flashing changes. Between the two we are working, planning, and discovering; and we are making progress—progress fully commensurate with present day developments. Our goal is the increased prosperity of several industries and a greater measure of happiness for the farm family.

There have been several noteworthy developments in farm electrification during the year.

Electric Tractors. Last summer the Detroit Edison Company equipped a garden tractor with a one-horsepower, variable-speed motor, a cable take-up, and an overhead power distribution system. Most of the parts used in the construction of this tractor were standard equipment. The gas engine of the tractor was replaced by a 220-volt, variable-speed electric motor. The motor was connected to the driving mechanism through a 9¾-to-1 speed reducer. Power was supplied to the motor through a rubber-covered, superservice cord which wound automatically on a constant-duty reel. Power drops from the overhead distribution system were provided at intervals of about one hundred feet, to which the lead from the tractor was readily and securely attached by means of twist-lock plugs. The distribution system supplying power for the tractor also provided light for harvesting vegetables for the early morning market.

This little tractor lacked much of perfection, but it was far in advance of the "mental" tractors and the dreams which were its predecessors.

Within the past few months another electric tractor has been used on property of the Middle West Utilities Company near Chicago. It has a multiple parentage, being the child of the Middle West Utilities Company, the Chicago office of the General Electric Company, the Caterpillar Tractor Company, and the Standard Storage Battery Company. This tractor derives its power from a storage battery. It stimulates visions of peakless farm load curves by taking its charge at off-peak periods. We have little information concerning this tractor except that it has been used, and that Mr. W. T. McCaskey, dean of farm electrifiers, is its godfather.

Electric tractor developments of the year also include the electrified Synmotor. The Synmotor is a self-propelled cultivating machine which travels in a spiral about a central mast. Wires extending out from this mast give direction to the machine and supply it with electric power. The Synmotor was first built about ten years ago by Mr. Herbert I. Washburn of Magnolia, New Jersey. Last fall it was equipped with an electric motor for the first time and demonstrated outside of Philadelphia. Since the shape of the land covered by this machine is circular, its use involves a special planting and inter-tillage system.

One other development is of interest as having a possible bearing on electric tractor design. The Drum storage cell, the invention of a young Irish engineer, has attracted international attention. It is "a low-resistance alkaline battery of robust construction" and is said to have a voltage higher than any other alkaline charger, and to be rechargeable in a few minutes. The battery has been tested for driving locomotives on the Irish National Railways.

The three electric field machines which we have mentioned are typically American and differ rather widely from the heavy electric cable-plowing outfits of Europe. While they are still some distance from the sales promotion stage, they do present something from which to eliminate mistakes, and which may be improved in detail in our progress toward practical application. When we stop to consider that farm draft work, hauling, and heavy stationary jobs for which tractors are used, require an annual use of 14 billion horsepower-hours, and that the present total use of electricity on farms is less than 1 billion horsepower-hours, any kind of beginning in the field use of power is opening the door to possibilities of load building and rate reductions beyond our present conception.

Hay Driers. The hay drier has advanced considerably during the year toward a more general acceptance. The rotary kiln type of drier has increased in popularity, partly because of its cost, which is now as low as five thousand dollars, but also because of its smaller size for a given capacity and its lower drying cost per ton. Twelve Arnold driers are reported to be in use this summer, three in California, two in Louisiana, two in New Jersey, and one each in Alabama, Florida, Tennessee, Wisconsin, and New York. Koon driers are in use in Louisiana and Florida. Five

[1]Paper presented at the Rural Electric Division session of the 25th annual meeting of the American Society of Agricultural Engineers at Ames, Iowa, June 1931.

[2]Research director, Committee on the Relation of Electricity to Agriculture. Mem. A.S.A.E.

The first recognized major need for rural electrification was to extend to farmers the advantages of electricity as a source of light to facilitate human activity. Other uses of equal importance have developed at a surprising rate under the guidance of engineering research

Mason driers are in use in Illinois, Delaware, New Jersey, Louisiana, and Texas. Other types of driers are installed as follows: a Bayley tunnel type drier at Waco, Texas; a Fulmer tunnel drier at Nazareth, Pa.; a Louisville steam-heated rotary kiln at Houma, La.; a Louisville bin type drier near Montgomery, Ala.; a hot-roll drier near Erie, Pa.; and a Randolph drier at State College, Pa.

Eight agricultural experiment stations are making studies of hay driers or the mechanics of the process of drying. Seven stations have projects dealing with the quality of hay made by different methods, including a study of chemical analyses, dry matter, vitamin content, feeding value, and effect of sun and rain on hay quality. The Louisiana station has made changes in its single-drum rotary drier and is continuing investigations this year. An Arnold drier has been installed at the University of Florida, where it is being used for the drying of special hay crops in cooperation with the U.S.D.A. Bureau of Plant Industry.

The U. S. Department of Agriculture is working on hay driers in two locations. A rotary kiln drier was installed on the Department's dairy farm at Lewisburg, Tennessee, in 1930. Hay from this drier is being used in feeding tests both at Lewisburg and at Beltsville, Maryland. Further studies of the mechanics of dehydration are being conducted under the direction of Mr. W. M. Hurst at the New Iberia (U.S.D.A.) livestock experiment station in Louisiana. The experimental drier is of the conveyor type. In this experiment several bureaus are cooperating in the study of a variety of new forage crops and the comparative feeding values of different hays, as well as the economics of the drying process.

Perhaps the most outstanding work in determining the value of artificial curing of forage has been done on two farms—the Brook Hill Farm at Genesee Depot, Wisconsin, and the farm of the Walker-Gordon Laboratories at Plainsboro, New Jersey. These large dairies have cured hay artificially in large quantities for several years and have kept careful records of cost, quality, and comparative values.

The agricultural engineer should understand that the hay drier is not solely for the purpose of saving the hay crop from the rain. Experimental work so far conducted indicates that the use of the hay drier will enable the grower to turn out a product having a higher protein and carbohydrate content and less crude fiber. It will enable him to save approximately ten per cent of the total weight, normally lost in the leaves, and another five to ten per cent of total weight due to transpiration in field curing. It also makes possible the more efficient organization of the labor program, by not having to wait on the weather.

Some of the new driers are made in portable types. The weight is too great however for ease in moving, and it is not likely that the drier will become a portable rig. Best results may be expected from stationary equipment. This makes the use of electricity for power both feasible and desirable. The power requirements vary from a few horsepower for turning the drum up to one hundred horsepower or more for the different types of machines and different fineness of chopping and grinding.

Effect of Light on Plant Growth. The growth of plants, flowers, and vegetables under glass is becoming an industry of large proportions, particularly in the neighborhood of large cities, where power lines are usually accessible. Studies of the effect of light on plant growth have been under way for a number of years, but the results of these studies are not generally known to commercial growers, and the use of light has not developed to any great extent.

The Boyce Thompson Institute[3] at Yonkers, N. Y., has done the most in determining the effect of light on plants. They have found that with respect to blooming, some plants are short day plants, some long day plants, and some are indifferent to light conditions. Salvia, for instance, grows well during long days, but will not flower if given more than 16 hours of light. On the other hand, lettuce grows and forms heads when the period of light is shorter than 12 hours, but does not flower until the days reach a length of 15 hours. Buckwheat produces flowers irrespective of the length of day, but grows better during the long days. It was also found that tomato plants die in a short time if given 19 hours or more of light per day.

Sweet peas, petunias, and snapdragons flower profusely on a 24-hour day. R. H. Roberts of the University of Wisconsin reports that light stimulates blooming of cyclamen, primrose, fuchsia, and schizanthus. T. H. White, of the University of Maryland, found that calendulas and some roses may be brought into bloom out of season by the use of lights.

It has also been found that certain physical or chemical treatments, in combination with light, produce desirable results. Sweet peas, for instance, blossom most luxuriantly when given light at the lower temperatures, while the buds of lilacs and other woody shrubs can be forced into growth before the termination of their rest period through the use of such chemicals as ethylene dichloride. An increase of the carbon dioxide content of the air will increase the height and the flowering of certain plants.

Other studies have shown that light of different qualities and wavelengths has varying effects upon plants. In general, plants will grow normally without any ultra-violet. Light from the blue-violet end of the spectrum produces short, stocky plants of strong color, while light from the red end of the spectrum encourages tall, spindling growth, with very little color.

Popp[4] found that plants grow taller in the total absence of sunlight. Under lights of different wavelengths, the maximum height was reached under red filters, and the minimum height under blue filters.

An interesting investigation is now under way at the Smithsonian Institution in Washington. Seedling plants are being grown in a small chamber, where lights of known intensities and wavelengths are applied to opposite sides of the seedling. The effect of the different lights on the growth of the plant are determined by the degree and rate of bending of the plant toward the light. Since the cell growth of the plant takes place in the absence of light, the darker side of the plant will be elongated most, and bending will be in the direction of the more potent illumination.

Light which has been passed at an angle through a number of plates of plane glass, and thereby polarized, has been found by Macht[5] to produce more rapid growth of certain plants than light from the same source passing perpendicularly through the same plates of glass.

There is still some discussion of the effect of ultra-violet light on plants. Some investigators claim that plant tissues are injured by ultra-violet radiations. Others claim some benefits. The Boyce Thompson Institute reports: "The amount of injury increased rapidly with decreasing wavelength from 290 mu. . . . The open arc, without a filter, caused considerable injury in thirty seconds." A report by McCrea[6], however, states that the potency of the drug plant, digitalis, or common foxglove, was consistently increased under Michigan conditions by growing the young plants in greenhouses under ultra-violet transmitting glass.

The laboratory studies of light are increasing. A new project has been established at Purdue University this year, in cooperation with the Utilities Research Commission, Inc., an agency of the Insull companies of Chicago. The Division of Radiation and Organisms of the Smithsonian Institution has only recently been organized.

There is need for the tabulation of data on the effect of light on the more common plants produced commercially. Until such information becomes available, perhaps the best guide for the use of lights in growing plants out

[3] "The Boyce Thompson Institute for Plant Research, Inc." Journal of Chemical Education, Vol. 6, No. 9, September, 1929.

[4] H. W. Popp, "A Physiological Study of Effect of Light of the Various Ranges of Wavelength on the Growth of Plants." American Journal of Botany, Dec. 1926.

[5] "Concerning the Influence of Polarized Light on the Growth of Seedlings," by David I. Macht. Journal of General Physiology, September 20, 1926.

[6] "Prolonged Effect on Digitalis Purpurea of Exposure Under Ultra-Violet Transmitting Glass," by Adelia McCrea, Research Department, Parke Davis & Company. Science, March 28, 1930.

Electricity has found extensive use as a source of power for farm mechanical refrigeration systems. Experiments in reversing the process for heating purposes are in progress

of season is a close observation of these plants under normal growing conditions. If a plant flowers profusely during long summer days, it can be expected that long hours of artificial light may have some influence upon its growth in the greenhouse during the winter. If, however, the plant does not bloom during the long days of summer, it would not be reasonable to expect it to do so under long hours of light in the winter.

Soil Heating. The work of Garver at Washington State College, Parks in Missouri, and Nixon at Cornell, has continued to point out the feasibilty of the electrically heated hotbed.

In 1930 the Harris Seed Farm of Coldwater, N. Y., equipped eighty cold frame sash with heating elements, using one 120-watt element to each two frames. These elements prevented freezing, when the frames were covered with burlap pads, at outside temperatures of 22 degrees (Fahrenheit). This year the same company installed 90-watt elements under more than two hundred sash.

On the National Rural Electric Project (College Park, Maryland) we have been making some comparisons of beds heated with elements beneath the soil, and above the soil. Plants grew satisfactorily in both beds. The cabbage plants in the heated air bed grew larger and thriftier than those in the heated soil, while the tomato plants did just the opposite. Head lettuce seed in the heated soil bed germinated more quickly.

A year ago, a Japanese market gardener near Long Beach, California[7], installed heating units made of No. 14 weatherproof wire in a plot of ground 40 by 110 feet for the production of early cucumbers. The wires were laid 4 feet apart and 8 inches deep under the rows. An adjoining check plot was unheated. The soil temperature was controlled at 70 degrees one inch above the heating wires. The result was a perfect stand of cucumbers, and a crop three weeks in advance and all marketed before the unheated crop came on. The power used was at the rate of about 24,000 kilowatt-hours per acre. The cost for a 41-day period was $40. The installation cost for one-tenth acre was $100.

Two companies report the sale of some lead-covered heating cable during the past year. Most of the hotbed elements sold, however, were of the space-heater type. The advantage of the lead-covered cable from the standpoint of labor and cost of installation is unquestioned. A difficulty is presented, however, in getting the user to understand that, if a certain piece of cable radiates 200 watts, a cable of twice that length will not produce twice the heat. With a heating element so easy to manipulate as the lead-covered cable, educational work may be needed to prevent dissatisfaction resulting from a lack of understanding of the principles of electric heating.

This is only one of the many problems still to be solved. So far we have been imitating the old manure hotbed without entirely knowing the reason why. We need definite information concerning the heat, moisture, and ventilation requirements of different plants. There are also the mechanical problems of temperature control and the economics of construction and insulation.

Water Heaters and Sterilizers. The electrically heated gravity-flow water tank has increased in popularity during the year. The chief advantage of these tanks is their low first cost, a factor which is ever of importance in farm electrification.

The open tub type of hot water tank is being recommended in New York state for scalding dairy equipment on small farms. When properly done this scalding process is quite effective in reducing bacteria count. Tests made by M. H. Berry of the Maryland Agricultural Experiment Station resulted in an average of 99.8 per cent reduction in bacteria with water at a temperature of 180 degrees. The utensils were turned continuously during the scalding process and were too hot to touch with the bare hand when taken from the water. In order to be sure that the reduction was due to scalding and not to rinsing, similar tests were made using cold water with very little reduction in the bacteria count. This is encouraging from the standpoint of the small dairyman who wishes to produce sanitary milk. The weakness in the system lies in the human factor involved.

Considerable progress has been made toward the development of a satisfactory electric dairy utensil sterilizer of relatively low wattage and power consumption. Sterilizers of this type have been built and tested on the National Rural Electric Project in cooperation with the Cherry Burrell Corporation of Baltimore. In this sterilizer only enough moisture is used to produce a saturated atmosphere at sterilizing temperatures. Repeated weighings indicate that this amount of moisture normally adheres to the utensils after ordinary washing and rinsing. The main features of this sterilizer are the elimination of the human factor by automatic timing, the even distribution of heat, the relatively low operating cost, and the dryness of the utensils upon completion of the process. In use the wet utensils are placed in the sterilizer, the door closed, and the switch snapped. No further attention is necessary.

Studies of the efficiency of bacteria reduction in this sterilizer have been very encouraging. The reduction was better than 99 per cent for practically all temperatures and holding times above 180 degrees and 15 minutes. A very satisfactory reduction was obtained at a temperature of 150 degrees for 15 minutes. These temperatures were actual can temperatures, and not air temperatures as indicated by a thermometer.

Rotolactor and Milking Combine. A discussion of the year's research developments would not be complete without mentioning the "rotolactor[8]" of the Walker-Gordon farms at Plainsboro, N. J., and the new DeLaval combine system of milking. The "rotolactor" is a fifty-cow continuous milking unit. It is of interest to us mainly because of the boldness of its design and the extensive use of electricity for rotating the platform, washing, drying, and milking the cows, and for conditioning the air in the building.

The combine milker, developed at the Beltsville farm of

[7]"Electric Heat in the Field," by Mel Horton, Market Growers Journal, March 15 ,1931.

the U. S. Department of Agriculture, milks the cows, weighs the milk and conducts it to a receiver in an adjoining building without exposing it to the air. It involves not only a system of milking, but a system of management and barn construction in which the cows are brought to the milker instead of taking the milker to the cows.

Refrigeration and Mechanical Heating. Mr. P. T. Montfort of the Texas C.R.E.A. reports some interesting refrigeration installations for the farm storage of eggs. By having a cold storage plant on the farm, producers were able to market eggs of especially good quality by placing them in storage immediately after they were laid. The local increase in price in fall and winter eggs over spring and summer eggs was sufficient to yield a good profit above the cost of storage.

The preservation of fruits and other farm products by sharp freezing on the farm has not yet come to our attention. The commercial freezing and marketing of these products is, however, a reality. It is claimed that frozen fruits retain their natural fresh flavor much better than those which are canned. The most notable examples of frozen fruits are the berries from the Pacific Coast, and, more recently, peaches from Georgia.

The possibilities of farm cold storage become more interesting from an economic standpoint when we read of the successful use of refrigeration machinery for the heating of buildings during the winter. It is reported[9] that a house in Scotland has been heated by refrigeration equipment driven by a five-horsepower motor. The actual apparent efficiency of this installation varies from 200 to 300 per cent. Another installation is reported to be in use in Tucson, Arizona.

The use of a compressor for heating is a reversal of the process of mechanical refrigeration. There is no complete change in the form of energy, such as takes place when electricity is converted into heat by passing it through a resistor. On the contrary, the heat units which exist in air or water at any temperature are merely captured and stepped up to higher temperatures. The very high apparent efficiency of conversion is obtained from the formula for the Carnot heat cycle

$$\text{Apparent efficiency}^{10} = \frac{T_1}{T_1 - T_2}$$

in which T_1 is the temperature at delivery, and T_2 the temperature of the medium from which the heat units are extracted, both in degrees absolute. Thus if the heat is to be delivered at 100 degrees (Fahrenheit), and taken from the atmosphere or well water at 40 degrees, the apparent conversion efficiency would be

$$\frac{560}{560 - 500} = 9.33, \text{ or } 933 \text{ per cent}$$

A casual glance at this formula shows that the apparent efficiency may be made anything you wish, providing the increase in temperature is made small enough. This formula does not tell the entire story, but the principle does offer possibilities and is being investigated by a number of agencies, including the Utilities Research Commission, Inc., of the Insull companies.

New Equipment and Developments. There have been several new developments in wiring during the year. One company has brought out a flexible entrance cable which eliminates some of the costly pipe work in connection with service entrances.

Combination entrance and range switches and panels have made possible the simplification of house service.

The combination thermal breaker and switch, while not reducing the cost of wiring, is a very convenient substitute for a switch and fuse block in some locations.

Mr. Hobart Beresford of the University of Idaho reports very satisfactory use of multiple V belts in connection with the larger farm motors and machines. L. M. Roehl of Cornell University and the National Rural Electric Project both report the small V belt as an improvement over the flat belt for use with fractional-horsepower motors.

Several small electric clippers have made their appearance recently in competition with the larger, more costly equipment previously on the market.

The ¼-horsepower motor has demonstrated its ability on the National Project to operate a 4½-inch burr mill, providing a grinding outfit for the small farm costing less than $40 complete.

The photo-electric cell promises its entrance into the farm field in the near future for such operations as maintaining a uniform light day in the henhouse or greenhouse. These cells are now being used for grading beans and tobacco, and for other operations closely associated with farming.

SHOULD RESEARCH BE CONTINUED?

Conflicting opinions relative to research are held by different men actively engaged in farm electrification work. One farm electrification specialist suggests that research workers must develop new uses, or he will soon be out of a job. Another intimates that rural service men had better interest themselves in securing the adoption of the some two hundred farm applications of electricity, rather than spending time on anything new. Agricultural engineers are not fundamentalists in research. Our efforts have been very much on the side of practical application. We have assisted in developing electric brooders, feed grinders, ensilage cutters, water heaters, and other everyday farm equipment. While the adoption of these machines has been relatively rapid in comparison with the adoption of such equipment as the steel plow and the reaper, there is still some feeling that it might be speeded up.

There are several deterrents to a spontaneous and widespread adoption of electrical equipment on farms. First costs and operating costs are important factors. An equally important factor, which does not receive as much attention, is the high overhead due to the small amount of use of much of our farm machinery. The greater use of this equipment involves not so much the perfection of the machine itself as it does putting it to different uses, and in making changes in the system of management. We have tackled most of the easy jobs in the farm use of electricity. Machines have been improved, difficulties ironed out, shifts made from low speed to high speed, and a substitution made of electricity for oil or fermenting manure in producing heat, and now we are up against some of the real problems, involving major considerations of finance and farm economics.

Has the agricultural engineer gone far enough when he adapts the feed grinder to electric drive and the brooder to electric heat, and then leaves it to the salesman to sell and the farmer to apply; or should he follow through in an effort to make electricity a real influence in the improvement of farm living and farm income? If we follow through we must solve some bigger problems than the proper size of a portable motor. We must keep that motor busy enough hours in the year to pay its way and make a profit. If these additional jobs are not among the two hundred which have been mentioned, then there is field for additional research. If they are among the two hundred, but the farmer is not convinced, there is very evidently a need for some economic research to locate the difficulty.

With electricity furnishing less than seven per cent of the power used on farms, and with the opportunity for using electricity for purposes to which other types of power are not adapted, it would appear that we are only at the beginning of the development of farm electrification. Now that we have the easier and more showy jobs taken care of, it is time for us to apply ourselves more assiduously to a basic analysis of agriculture and its possible utilization of electricity, and to be courageous enough to undertake some of the problems which in the past have been too difficult and too unpromising for solution.

[8]"Milking Cows on a Merry-Go-Round." Hoard's Dairyman, November 10, 1930.

[9]C.R.E.A. Report on Farm Electrification Research (1931), page 32.

[10]"Reverses Refrigeration Process for House Heating." Electrical World, August 16, 1930, page 315.

Electric Soil Sterilization

By Lawrence B. Carney[1]

DECIDED PROGRESS has been made in the control of animal disease by observing recognized sanitary and hygienic measures. There is no reason why comparative results should not be obtained with plant disease, if similar fundamental principles are applied. The chief obstacle to advancement along these lines is the fact that the gardener will take no preventive steps as long as he can produce a fifty per cent crop. It is not until he is face to face with total failure that he will give the recommendations of the specialist even a trial. This usually comes too late to be of any value, and the next season, instead of following the advice given him, he hopes against fate that somehow conditions may be different this year, and the precautionary preventive measures of the preceding year are either ignored or forgotten with the same inevitable results.

It is a well-established fact that many plants become diseased while still in the seedbed or flat and are so weakened by the attack that they either do not develop into normal plants when set out in the field, or they succumb more readily to later infection[2].

Some insect pests and diseases harbor in the soil. This furnishes them protection against fumigation and chemical disinfectants. The most common pest of this type is the nematode, a tiny worm. The application of heat is apparently the only control method which is effective.

Because of the improved conditions for germination and the absence of damping off diseases, the amount of seed sown can be materially decreased when heat control is applied. No allowance need be made for those unfavorable factors which so often deplete the stand of seedlings. Elaborate systems have been designed such as the tile drain, inverted pan and perforated pipe, by which steam is used to heat the soil to the proper temperature.

The temperatures (degrees Fahrenheit) necessary for the control of common greenhouse pests, are as follows:

Nematodes	140 degrees
Pythium	140 degrees
Systoria lycopersici—spores (on tomato)	127 degrees
Rhizoctonia (on lettuce)	176 degrees
Selerotinia (on lettuce)	176 degrees

A simple way of telling whether the job of controlling the pests has been well done is to bury a medium-sized potato in the soil; when the soil is removed, it should be well done and mealy like a baked potato.

Heat control systems in use at present not only require a large investment in piping equipment but considerable boiler capacity to furnish sufficient steam. The operations of the growers of field crops who use small greenhouses, sash houses, and hotbeds are such that a heavy investment in piping can not be justified and large boiler equipment is not necessary for their regular operations of heating. It was to meet the specific needs of the market gardeners in the capitol district of New York that an electrically heated oven to sterilize soil in quantities of one cubic yard was developed.

The sterilizer consists of a one-cubic-yard box of ⅛-inch boiler plate, mounted two feet from the floor on angle-iron legs. The top is provided with a cover which is lifted for loading and a hinged bottom by which the soil is dumped after the sterilizing process is completed.

Heat is furnished by electric heating elements of No. 18 Browne and Sharp or American gage nichrome wire, in close wound, 3/16-inch coils, 8¾ inches long and placed in ½-inch galvanized iron pipe running parallel through the box, so spaced as to give the best distribution of heat. The wire is insulated from the iron pipe with porcelain tubes. Each end is welded to a brass bolt. This bolt in turn has a fiber washer to insulate it from the pipe on the outside. The electrical connections on the sides were wrapped with asbestos ribbon. In order to decrease radiation losses the sides and top are wrapped with a balsam wool blanket.

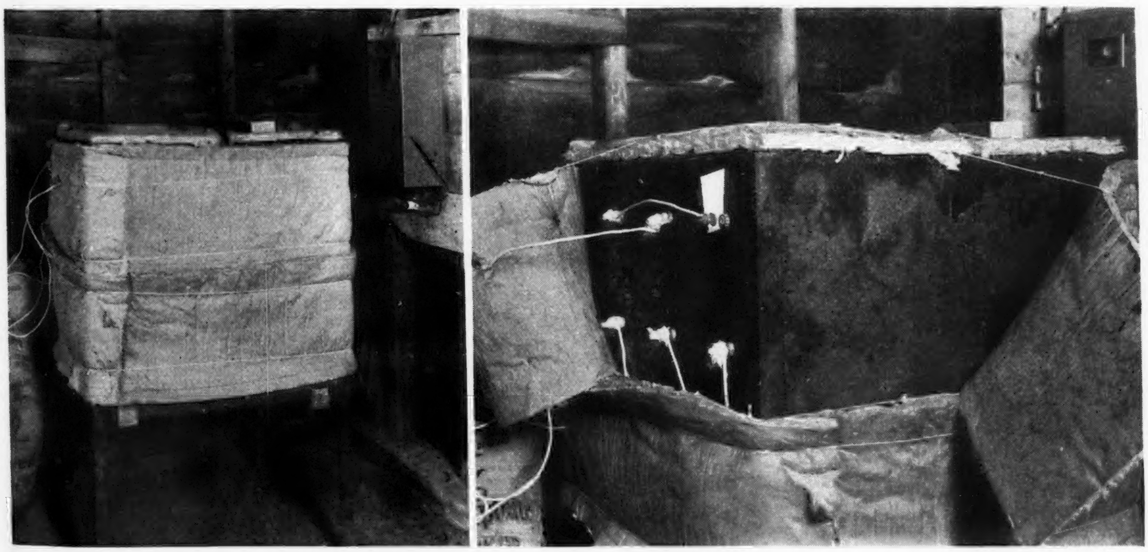
Several arrangements of the coils were tried at 230 volts.

In test I sixteen heating elements were arranged in four rows of four units each. Each coil was of 3.08 ohms resistance. With eight coils in series this gave a current flow of 1990 watts per circuit, or a total of 3980 watts.

In test II fifteen heating elements were used, seven in

[1]Rural service division, New York Power and Light Corp.

[2]This and the preceding paragraph is an indirect quotation from Bulletin No. 320 of the Colorado Agricultural College, by Walter G. Sackett.



The one-cubic yard electric soil sterilizer, (left) with insulating blankets in place and (right) with insulation laid back to show electrical connections

series, arranged in the lower fifth of the box, and eight in series near its horizontal center plane. This gave a current of 2280 watts in the lower portion and 1990 watts at the middle, or 4270 watts total.

Test III was the same as test II, except that three coils of 23.6 ohms resistance each were placed in the upper portion. These elements, made of No. 22 nichrome wire, increased the total wattage to 4980.

The capacity of the heating elements should be below 9 watts per square inch to prevent scorching of the soil.

Under normal operating conditions the sterilizer is run from 5½ to 6 hours, and will use 30 to 35 kilowatt-hours. It is difficult to state the exact operating time as conditions of outside temperature, soil temperature, moisture content, voltage, etc., vary. The grower must depend upon the actual temperature of the soil as indicated by an accurate thermometer to tell him when the equipment should be switched off.

Several improvements to be made in the design before the electric sterilizer can be put in commercial production are as follows:

1. The dimensions should be changed to adapt the unit for moving through ordinary greenhouse doors.
2. The spacing of the heating elements should be such that the whole soil mass rises more uniformly in temperature.
3. The insulation against heat loss should be of a more permanent nature, free from effects of moisture and mechanical injury.
4. There would be some advantage in so making the apparatus that it could be tipped on its axis to facilitate dumping, as well as loading, from the top.
5. Boiler plate construction is expensive and heavy. Wood might well be considered as possibly a better material for the purpose.
6. A thermostat or indicating thermometer would be of great service to the user.

Maurice Kane—Pioneer Farm Machine Designer

By E. H. Kimbark[1]

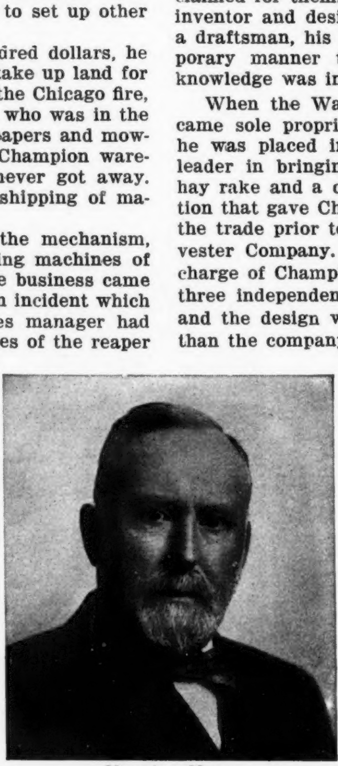
THE STORY of Maurice Kane is one of the many romances of America; and more particularly another romance based on the reaper.

Coming to America from Ireland at the age of thirteen, and locating as a helper on the farm of an uncle near Beaver Dam, Wisconsin, he rose by application and native talent to be manager of the engineering department, then the experimental department, of the largest farm operating machine company in the world.

As a lad on his uncle's farm he became familiar with the farm operations and farm machines of that time, particularly with the reaper which his uncle purchased and which the young man set up without instructions. This led to his employment by the local dealer to set up other reapers.

In 1871, having accumulated a few hundred dollars, he came to Chicago en route to Nebraska to take up land for a farm. He reached Chicago the day after the Chicago fire, intending to stay a few days with a cousin who was in the employ of the firm who made Champion reapers and mowers. Some extra help was needed in the Champion warehouse, and he went to work there, and never got away. Soon after that he was put in charge of shipping of machines and distribution of advertising.

He was interested from the start in the mechanism, adjustments and operation of the harvesting machines of that time. His interest in this phase of the business came to the notice of the partner in charge by an incident which he often related in later years. The sales manager had explained that a certain control of the rakes of the reaper was not possible on the Champion. Mr. Kane intimated to Mr. John J. Glessner, the Chicago partner, now an honorary member of the American Society of Agricultural Engineers, that the control desired could be effected on the reaper just as it was built. Later he was called upon to explain how it could be accomplished. This he did to Mr. Glessner's satisfaction.



Maurice Kane

My first acquaintance with Mr. Kane and with the harvesting machine business was in 1885. At that time he was frequently called on for trips to the country to adjust the grain binders which had recently been brought into the Champion line. He also went to the country to try out the new machines and make experiments. A considerable portion of the latter activity was in the immediate vicinity of Chicago—in fact, in territory now completely built up and within the corporate limits of the present city and its western suburbs. On these trips began my long and intimate personal acquaintance with Mr. Kane, and my lasting appreciation of his attractive personality, unfailing honesty of purpose, and the wide range of his ability.

While he was engaged in shipping machines, he would note the patent dates marked on them and would visit the public library in the evening to read the patents and learn what was new in the machines, and the advantages claimed for them. These activities led to his becoming an inventor and designer of harvesting machines. Not being a draftsman, his work was done by building up in a temporary manner the device which interested him. His knowledge was intensely practical.

When the Warder, Bushnell & Glessner Company became sole proprietors of Champion harvesting machines, he was placed in control of experiments and became a leader in bringing out a new grain binder, a mower, a hay rake and a corn binder, which lines were the foundation that gave Champion machines a prominent position in the trade prior to the formation of the International Harvester Company. Prior to the time when Mr. Kane took charge of Champion design, these machines were made by three independent companies which divided the territory, and the design was controlled by one of the three, other than the company with which Mr. Kane was connected.

Upon the organization of the Harvester Company the outstanding ability of Mr. Kane led to his selection as assistant manager of the experimental department, and in 1906, on the retirement of the manager, he was promoted to that position, which post he held until his retirement from active participation in 1913. He was thus brought into intimate contact with the design of other farm machines, and the mature judgment and resourcefulness he acquired in his long experience with harvesting machines along with his knowledge of farm requirements made him a force in the new developments.

His retirement did not end his interest in farm equipment, and he was a frequent visitor at headquarters until his death in October last.

[1]Assistant to manager, engineering department, International Harvester Company, Chicago, Ill.

The Factory Method of Milk Production[1]

By Henry W. Jeffers[2]

FOR MANY YEARS the Walker-Gordon Laboratories have been conducting at Plainsboro, New Jersey, a series of experiments and large-scale demonstrations designed to discover, develop and adapt to milk production and to agriculture in general some of the newer principles of business management, science and mechanics. During the past few years these efforts have been intensified.

While the principle objective has been the production of a clean, safe, nutritious milk of maximum biologic value at reasonable cost, this program has necessitated a second objective, the placing of agricultural operations on a modern industrial business basis.

While the viewpoint in all experimental work has been one of practical improvement of the product in the development and production of our milk, certain economic and farm management principles have been evolved which leading agricultural authorities believe may be valuable to agriculture in general, although as yet they have been worked out for only a single type of agriculture, namely, dairying.

Large-scale operation makes possible the use of machinery and equipment, which in turn makes large-scale operation more feasible and more profitable for all concerned. It is a well-known fact that the average farmer cannot afford the capital investment for some of the more efficient types of machines. A good example of the type of machinery made possible by large-scale farming is found in the "rotolactor."

THE ROTOLACTOR

Continuous production machines have been utilized to wonderful advantage in many lines of industrial endeavor, where the idea is neither new nor novel. There is one unique characteristic, however, distinguishing this particular machine from all other continuous production machines. It is the first time the idea of continuous production has been applied, as far as is known, to a process where the living animal plays so important a role. In fact, the cow was the basic element, the core around which the machine had to be designed.

Our first step was to determine experimentally whether or not a cow would step onto a moving platform. Many wise people predicted that she would not. We built a wooden platform about 20 feet long, mounted on rollers, and divided the space on top into six stalls by means of wood partitions. This was towed past a fixed opening at a constant speed of about 15 feet per minute. A group of six cows were chosen at random to make the test. To the surprise of many of the forecasters, all six stepped onto the moving platform without undue hesitation.

Then we came to the question of milking machines, a subject on which there were many schools of thought, many diametrically opposite and yet firmly entrenched opinions. A strange and subtle impression that the milking machine is harmful to the cow seemed to prevail. To our engineering minds the milking machine offered the finest opportunity in the whole experiment to apply the idea of automatic mass production. Consequently these rumors were for the most part discounted. Here was the chance to eliminate the possibility of human contamination of the cow or milk, and the opportunity to introduce an absolutely uniform milking action to which the cow would react favorably.

We were fortunate in being able to interest the research department of one of the large milking machine manufacturers in our problem, and the many ingenious mechanisms which they developed opened up a vast field of new possibilities for the automatic milking of the cow. Meanwhile the design of the rotating table and driving mechanism was crystallized into a definite form.

Substantially, the table consists of a large annular ring about 8 feet wide and 60 feet in outside diameter. On this table are fastened fifty stall partitions radiating out from the center of the circle. To these partitions are attached the milking machine jars, actuating valves, vacuum pipes, and neck stanchions or yokes for fastening the cow in place. The table is fabricated of structural plates and shapes surfaced with a concrete floor, and presents no unusual features. In contracting for the fabrication of the steel work we found very few shops equipped to bend the circular members within the limits of accuracy we required. The structural steel firm with which we placed the contract did a very creditable piece of work, considering that when finished the circular table was true to within ⅜ inch.

To the bottom of this annular steel ring are bolted two standard 60-pound rails, bent to form concentric circles, and rest on a series of supporting wheels in such a manner that the whole table can rotate around an imaginary center pivot. These wheels, which are really small-diameter railroad car wheels, are mounted on Timken bearings. It is essential in a slow-moving, heavy machine of this nature, which starts off under practically full load, that the starting friction be reduced to a low value, otherwise the higher starting torque would require correspondingly larger electric motors. The usual type of sleeve bearing would, on standing for a time, squeeze out the sustaining oil film, forming metal to metal contact. The wheels are mounted in supports, which are bolted down on concrete pedestals. Altogether there are twenty-eight of these supporting wheels.

For driving this rotating table, we again found it desirable to develop along somewhat original lines. Plenty of ideas were forthcoming, such as employing a rack and pinion, belts, chains, or a center pivot drive as is found on amusement merry-go-rounds. But all of these have disadvantages which were considered to have outweighed their relative good points. When the idea of using friction to drive the table by means of one or two of the supporting wheels was proposed, there were many expressions of opinion that the scheme was impracticable, the objection being that there was not enough traction in two ordinary railroad car wheels to move a heavy table weighing eighty tons. The objectors seemed to think that teeth were necessary to obtain motion. Delving into history, we found that the same objection was offered to the first steam locomotive friction drive, it being strongly asserted that the drivers would only spin around, accomplishing nothing. Each generation seems to develop the same school of thought, differing only in its application. But in the end we resorted to and were successful in the development of the friction drive.

There are four of these driving units, hinged in back and supported by adjustable springs in front. By tightening these springs the friction between the rail and the driving wheel can be regulated. Each weighs approximately 2,000 pounds and presses upward against the rail with a force of about 5,000 pounds. Strange as it may seem, less than 1½ horsepower is necessary to drive the table at its present speed of one revolution in 12½ minutes. This is divided equally between two diametrically placed units. It might be mentioned here that only two of the four units are in operation at one time, the other two being spares. The units have variable-speed, direct-current motors and are attached to the driving wheel through a

[1]A paper presented before the Dairy Engineers' Institute—sponsored by the Committee on Dairy Engineering of the American Society of Agricultural Engineers—held in connection with the National Dairy Industries Exposition at Atlantic City, New Jersey, October 1931.

[2]President, Walker-Gordon Laboratories.

reduction gear with a ratio of 750 to 1. By means of a control board located in the machinery pit, the speed of the table itself can be varied from an upper limit of one revolution in twelve minutes to a lower limit of one revolution in twenty minutes. This control is effected by means of rheostats in the field circuit of the motors.

There were several features included in the milking apparatus, as applied to the rotary table, that could not conveniently be incorporated into the design of any other existing milking system. The valves controlling the vacuum, the admission of sterilizing water to the glass jars, the releasing of milk from the jars, and the releasing of milk from the weigh tank are automatically actuated by the motion of the table itself. Each milk jar with the attached teat cups is completely rinsed and sterilized before being used in milking another cow. The weight of the milk from each cow is recorded in the same rotational order the cows occupy on the milking table.

Essentially the milking system is made up of fifty milking units, each unit including a jar, two vacuum control valves, a magnetic pulsator control, and teat cups with their attached rubber hose. There is one milking machine unit for each stall on the rotary table.

Slung from the under side of the table are the two rotary vacuum pumps, together with three low-voltage motor generating sets for furnishing the current to the magnetic pulsator valves. Both the vacuum pumps and motor generating sets are in duplicate so that if any trouble should develop the load can be instantly thrown over to the other set. This policy has been followed throughout the design of the entire system as far as possible in order to reduce the hazard of a breakdown.

In the early stages of the design of the milking machine, it was suggested that, if possible, the milking pails should be constructed of glass. The glass jars make visible the complete rinsing and sterilizing process to which they are subjected between each individual milking.

HOUSING AND OPERATION

The brick and tile building housing this machine is fitted with modern air-conditioning equipment to maintain a constant and desirable temperature and humidity. The air-conditioner also cleans and washes the air, thus reducing dust and bacteria to a negligible factor.

Leading into this building from the outside and up to the edge of the rotating platform is a covered runway through which the cows enter to be milked. As each cow in turn approaches the rotating platform, a vacant stall appears before her and she steps into it. A stanchion automatically closes about the cow's neck, and the platform slowly moves her to the left. Here a shower bath is administered and other cleansing operations performed by an attendant during the first 2¾ minutes that each cow is moving. Next comes the drying process with blasts of warm air which quickly and completely dry the cow. Next the fore-milker tests each quarter of each cow's udder to make certain that no unhealthful condition has developed since the previous milking. Next an individual milking machine mounted on the revolving platform is attached to each cow and during the remainder of the 12½ minutes required for one complete revolution, the milking operation is completed, the milk drawn through sterilized airtight tubes to the individual sealed pyrex glass containers, and dumped into the automatic weighing and recording machine.

At the completion of the revolution, each cow finds herself facing an open runway, her stanchion opens, and she steps off the platform and passes down this runway through the central chamber, out underneath the rotating platform and back to her stall in the barns.

Walker-Gordon cows are milked three times a day — morning, afternoon and night. With a capacity for milking 240 cows per hour it requires only six hours to handle, with the rotolactor, the 1400 milking cows at the Plainsboro plant. Practically no difficulty was experienced in accustoming the cows to the rotolactor.

We have already noted many advantages after operating for a year. There is a very important saving in labor costs. Only ten to twelve attendants are required to operate the machine. It eliminates milking in the housing quarters. With milking machines scattered through many barns, it is not practicable to sterilize each machine before applying it to another cow, and the risk of spreading infection is great. With only a few milking machines, and these all concentrated at one point, sterilization of the essential parts is easy and automatic. Quick and systematic milking in a central building makes possible the adoption of a new system of management, feeding and care of the dairy animals.

Most important of all, however, from the standpoint of producing our quality milk, is the fact that this concentration of the milking operation in a central building, properly equipped to assure freedom from dirt and dust, gives us the opportunity to attain standards of cleanliness never before approached. This change does for the dairyman what moving the patient from the home to the operating room of the hospital has done for the physician and surgeon.

DEHYDRATION

Another subject in which I think you may be particularly interested is the dehydration process which we have worked on for the last five years. At our plant in southern New Jersey, at Juliustown, we have the single-drum, rotary type of drier similar to those used in cement plants, beet pulp mills, and sewage disposal operations. At Plainsboro we are using the triple-drum type Arnold "Ardrier" and a conveyor type machine built by the Mason Alfalfa Process Company. We produced 2700 tons of dried alfalfa in the three dehydrators at the two plants this year.

The more I study the methods employed in drying forage crops, the more I am convinced that the present trial-and-error method of developing the dehydrating machines to maximum efficiency is slow and expensive, but probably the only method that is practical at the present time.

There are a few basic fundamentals that must be met in the design of a hay drier: (1) The operation must be continuous, (2) the machine must be of a size which will permit continuous operation of standard field equipment, (3) it must operate with high efficiency, (4) it must be economic in construction, (5) low overhead and depreciation are necessary, (6) the power requirement must be low and (7) the machine must be as far as possible automatic, reducing labor to a minimum.

I believe that dehydrating machines at the present time have reached an economic stage, but that there is a great opportunity for increasing their efficiency and the quality of the product turned out.

There are many advantages resulting from the use of a dehydrator, both from the standpoint of farm and labor management and from the improved quality of the feed produced. The principal advantage is that hay drying presents only a minor labor problem. A haying crew can work continuously from spring until late fall, rain or shine, night as well as day when necessary, and the hay is cured with a minimum of handling. In the Walker-Gordon system, this is important from the standpoint of management of the crop farms since freedom from haying interruptions leaves ample time to cultivate the corn crop the required seven or eight times during the growing season.

A variety of losses are avoided. There is no loss from rainstorms, mold, or hay overheated in the mow. In many sections of the United States it is impractical to grow alfalfa hay because of the difficulty in sun-curing.

Even more important is the avoiding of the loss of fine leaves—the best part of the alfalfa plant. Few realize the full extent of this loss Even under the best western conditions, losses of this kind amount to about twenty per cent of the original dry weight of the alfalfa plant.

Dehydrated alfalfa hay has a much higher protein and fat content and a lower fiber content than sun-cured hay, the latter being largely due to the loss of the fine leaves in sun-curing.

The general practice of making hay while the sun shines has not been changed in principle since historic times. It is a most wasteful system both as to quality and

quantity. Recent discoveries show that all young plants, whether grasses or legumes, are high in protein content. Other discoveries show that young plants rapidly desiccated shortly after cutting become "concentrates," while these same plants allowed to grow to maturity and cure in the sun form "roughages." Feeding tests show that the fiber in young plants is fully as digestible as the starches.

Such crops as rye and wheat, which are ordinarily not used as a dried forage feed, may be dehydrated and offer an early spring feed, of heretofore unappreciated nutrient value. Late cow peas and soybeans, which would otherwise mature too late in the year to save, can be turned into excellent feed by dehydration.

Professor Walter C. Russell, of the New Jersey Agricultural College, has expressed the belief, based on experiments, that artificially cured alfalfa is about seven times as rich in Vitamin A as sun-cured alfalfa.

The dehydrator opens up the possibility of growing forage where it will grow best. Excellent alfalfa can be grown in several of the southern states where rain is plentiful and the growing season long, but where the hay cannot be successfully sun-cured. Certain vigorous growing plants, which cannot now be successfully sun-cured at all, yield to the dehydrator.

This is, apparently, an opportunity to further decrease the costs of producing milk while at the same time increasing the quality through higher vitamin and mineral content.

The dehydrator on the Walker-Gordon farms has been put to additional use in drying manure. The capacity of the cylinder dehydrator leaves it free for use each night to dehydrate the manure collected during the day. This was, in fact, a major consideration in developing the dehydrator at our Juliustown plant. The finished product emerges in a thoroughly dry, odorless, pulverized state and resembles prepared feed. This material finds a ready sale for use on lawns, golf courses and truck crops. With continued decline in the horse population and the removal of dairy cows to greater distances from the cities, the demand for this humus-bearing fertilizer may be expected to increase.

The rotolactor and the process of dehydration represent the application of engineering principles, in rather a new way, to an age-old industry. It is hoped that the application of such engineering methods, together with principles and methods borrowed from the scientific and business worlds, will eventually result in a comprehensive plan of volume production that should point the way to improvement in the social and economic status of American agriculture.

Use of Machinery in Cotton Production[1]

By John W. Randolph[2]

ACCORDING to reliable information, the "one-mule" cotton farms in the southeastern states are operated at little or no profit. Some authorities go so far as to say that cotton growing is doomed in the regions east of the Mississippi River. In the Southwest farm machinery has been an important factor in making cotton production profitable, especially in Texas and Oklahoma. It is believed that the use of larger farm machinery in the southeastern states will make is possible to continue to grow cotton profitably in that region on land adapted to cotton culture.

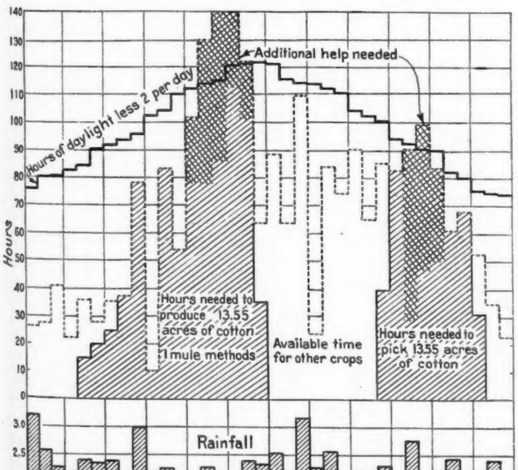
[1]A paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Atlanta, Ga., February 1931.

[2]Agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

A study of an average one-mule farm in the Southeast makes obvious its unbalanced program. The farmers in Marshall, Dale and Tallapoosa Counties, Alabama, grow an average of 13.5 acres of cotton and a small acreage of other crops[3].

Before attempting to show how many hours of labor is wasted by each farmer, it is worth while to consider why the landowner, in years of good cotton prices, wants his tenants to raise only cotton upon his small acreage. Fig. 1 is a graphic time study of a 13.5-acre cotton farm having a comparatively light clay soil. The upper solid line shows the total hours of daylight (less two hours per day) for each 10-day period throughout the year. The shaded area represents the man-hours of labor required to grow cotton on the basis of the data given[3]. The double-

[3]U.S.D.A. Bulletin 896.



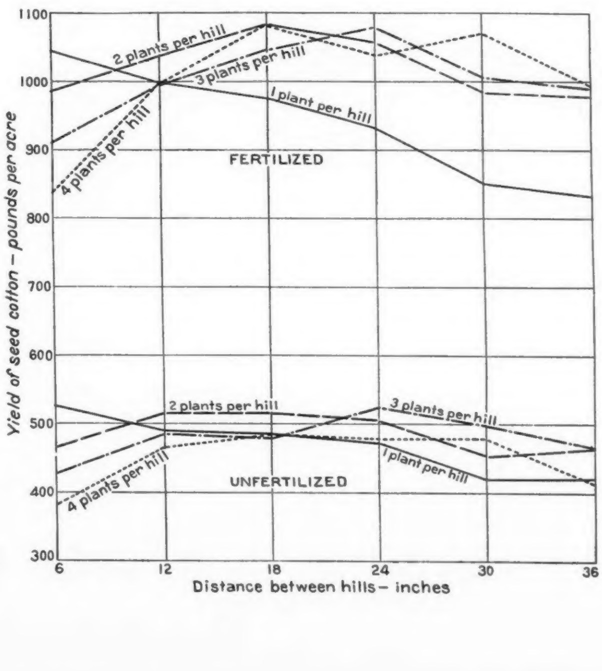


Fig. 1. (Above) Man-hours required to grow 13½ acres of cotton. Fig. 2. (Right) Cotton spacing tests at Alabama Agricultural Experiment Station

shaded area above the shaded area shows the extra labor required at certain periods. The bars at the bottom of the graph show the total rainfall in each 10-day period. It is seen from this graph that extra labor had to be hired to hoe the cotton and again during the picking season.

This graph shows that the two peaks of labor requirement make it necessary for the southeastern cotton farmer, with the prevailing methods, to depend largely on the one crop. Uncertain weather conditions make it impossible for the farmer to estimate the amount of extra labor needed or how much land he can cultivate. However, to insure a satisfactory income, the farmer must grow a certain quantity of products with sufficient spread between cost and market value. Good seed and fertilizer go hand in hand with efficient use of labor and power.

In the mechanization of cotton production the selection of the equipment should be made with reference to the acreage and the available power and labor. Any changes made in the existing methods should have for their objective the maximum income per farm worker. If it is considered that the operations listed represent the ideal method of cotton production, it is apparent that a marked improvement can be made in the efficiency of machine operations. For example, several of the operations listed could be combined by using the modern combination planter.

The source from which these data are taken[3] further indicates that small tools were used in many operations in which the various harrows could have been employed. Many planters give as their reason for this that they have to keep their help busy so that they will be on hand for the hoeing and picking. To make any material progress in more efficient cotton production it will be necessary to make a marked reduction in the time devoted to hoe labor.

Several experiment stations have conducted experiments in the spacing of cotton plants in the row. Data on this subject compiled by the Alabama Agricultural Experiment Station are shown graphically in Fig. 2. These results and those of other stations show that the cotton plant has great ability to adjust itself to almost any reasonable spacing. In a favorable year unthinned cotton gives a satisfactory yield. In this connection it should be pointed out that the agricultural engineer is more interested in production per worker than in yield per acre.

Fig. 2 indicates that the spacing of cotton plants is comparatively a minor problem. This allows the agricultural engineer considerable latitude in working out methods to reduce hand labor. Since the spacing of the plants is not an important consideration it follows that the control of weeds is the chief objective in hoe work. The old proverb "An ounce of prevention is worth a pound of cure" is especially applicable to this problem. Proper preparation of the seedbed and greater use of the various harrows is employed by the more progressive farmers to reduce the amount of hoe labor. However, experimental data are lacking with which to establish the exact value of such savings in labor.

Planting just enough seed for a stand of cotton is inadvisable. Heavy rains are likely to occur during the planting season and nearly every year a part of the crop is damaged by baked soil or cold weather at the critical stage of germination. It is necessary under these conditions to have plenty of seed in the ground so that the expanding power of the germinating seed will be sufficient to break the soil crust. Also a heavy stand is more resistant to the diseases that accompany cool weather and will better survive the attacks of cutworms.

The desire for high yields per acre has resulted in the close spacing of cotton rows and maximum profitable rates of application of fertilizers. Such intensive farming often prevents the greatest efficiency of labor. Crop row spacing should be based on the maximum production per man rather than per acre. The one-row riding cultivator set for a 30-inch row may turn over on a moderate slope. On the other hand, if the rows are spaced too wide, an extra trip with the cultivator may be required.

Data from Clemson Agricultural College[4] shows that cotton planted in 32-inch rows produced only 10.9 per cent more lint than cotton planted in 42-inch rows. A man can cultivate a 42-inch row in about the same time as required to cultivate a 32-inch row. The wider spacing would result in 17.2 per cent more cotton on the basis of time required to produce the crop. When consideration is given to the saving which would result in the use of more modern machinery on the wider rows, the comparison becomes still more favorable to the wider spacing and emphasizes the fact that yield per man is of greater importance than yield per acre.

[4]Clemson Agricultural College Circular 101.

Arkansas data[5] show that the prevailing practice of planting cotton on beds can not be set down as an unnecessary operation without further investigation. Soil and weather conditions will vary the results from this practice. The beds can be made with many of our modern implements and may be regarded as a part of the seedbed preparation. An attempt should be made to improve this operation.

It has been proven that the spiketooth harrow, weeder, and rotary hoe can kill small weeds and may be used to remove extra cotton plants within the limits of the best practice. The effect of cross harrowing and check-row planting upon the reduction of hoe labor varies. Some workers report that in favorable seasons hand labor has been eliminated by these means.

The time required to cultivate an acre can be greatly reduced through the use of improved power and mule cultivators. The extension services of several states have emphasized the greater use of the cultivator. However, many of the existing machines are not able to operate satisfactorily on the hill farms of the Southeast because of their lack of flexibility and strength. Many farmers are unable to obtain accurate control of their implements and are compelled to operate the sweeps so far from the plants that hoe labor may be increased by the use of the cultivator.

With the available knowledge, it is impossible to make general recommendations as to the best machinery for cotton production on farms of different sizes and with varying soil and topography. The agricultural engineer needs information comparable to that obtained by the agronomist regarding soils, fertilizers, and seed selection. For example, we should know how to reduce the injurious effects of crust formation; how to handle a given soil so as to promote maximum crop growth with a minimum of cultivation; and how best to combat the growth of weeds and grasses.

[5]Arkansas Agricultural Experiment Station Bulletin 161.

Mathematics for Engineers[1]

BLIND faith in mathematics will not do, at least for the engineer. He must understand its true nature — that it is only a method of reasoning. He must proceed with mathematics in one hand and common sense in the other, keeping ever a lookout for the reasonableness of his results. Nothing reasonable ever came out of a computation which was not originally put into it in the fundamental assumptions. No calculation can give a result more accurate than the data on which it is based. Mathematical concepts are perfect, the physical conditions to which the engineer applies them never are. All results are in error and it behooves the engineer to know (within limits) how much. His result may be accurate to one-tenth of one part in a million, as in his analysis of the impurities in drinking water, or plus or minus 50 per cent, as in his calculations of the stresses in a structure built to withstand the vagaries of the storms. All formulas are empirical, in that the "rational" ones are derived from empirical ones. . . . .

[1]From Ohio State University Engineering Experiment Station Circular No. 27, "The Usefulness of Mathematics to Engineers," by P. W. Ott.

A Method of Studying Soil Erosion[1]

By M. L. Nichols[2] and H. D. Sexton[3]

THE GREAT economic importance of the control of erosion is apparent throughout the southeastern section of the United States. Many persons familiar with agricultural conditions have been advocating various means of erosion control for a great many years. As a result, terraces and cover crops are considered by the better farmers as a necessary part of any sound system of crop production on our rolling lands.

The best methods of control and the conditions under which these should be applied are, however, at present largely a matter of opinion. This is particularly true of sheet erosion and of the relationship between various tillage operations and soil losses. For this reason, a rather general attack has been made on this problem by both federal and state agencies.

The studies in progress in different sections of the country vary widely in methods of attack and give evidence of considerable variation in the viewpoint of the workers. The brief discussion of methods in this paper, with sufficient preliminary results to allow an approval of their value, is offered as a possible contribution to the work in this field.

The objects of the project are to determine (1) the relationship of various soil factors as well as topographic and climatic factors to erosion and (2) to determine the natural laws governing or affecting these relationships as a basis for soil management and terrace design. It is assumed as a working hypothesis that there are laws governing the action of water on soil which probably can be mathematically expressed in terms of measurable soil properties.

METHOD EMPLOYED IN STUDYING EROSION

The variables entering into this study are classified in Table I. These are measurable or controllable for experimental work. The procedure consists of varying one controllable factor through a desirable range and holding the others constant, or measuring them when they are dependent. The project is planned to include the use of a variety of soil containers of various capacities with a wide range of soils, and to make studies of properties such as permeability and amount of flocculation. At present investigations of rapid methods of soil analysis and moisture content are being made to determine their adaptability to these studies. A discussion of the supplemental laboratory measurements and tests necessary for an understanding of erosive effects will not be attempted here, but they must be given careful attention if more than a superficial knowledge is to be attained.

Equipment for Controlled Experiments[4]. This equipment consists essentially of ten plots inclosed with concrete sidewalls. A diagram of this construction is shown in Fig. 1. Each plot is 50 by 15 feet, or 1/58 acre. This size was selected as it was considered sufficiently large to permit tillage practices similar to those employed in ordinary field crop culture, and at the same time small enough to permit control measures with a sufficient degree of uniformity. The plots are arranged in pairs. The first pair is level and the succeeding pairs have slopes of 5, 10, 15, and 20 per cents, respectively. At the lower end of each plot is a concrete cistern 3 feet wide, 15 feet long, and 5 feet deep. These cisterns are arranged so that they can be cleaned and drained after measuring and sampling the eroded material.

A 3-inch water main leads to the edge of the plots. From this main a 2-inch pipe is run to the upper end of each plot. These pipes supply water for the artificial rainfall system. The apparatus used to apply the artificial rain (Fig. 2) consists of two ¾-inch galvanized iron pipes 50 feet long with Skinner cat-fish nozzles placed a foot apart in each pipe. These pipes are supported 3 feet above the level of each plot and approximately 3½ feet from the edges of the plots. Each pipe containing the nozzles is

[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers at Birmingham, Alabama, February 1932.

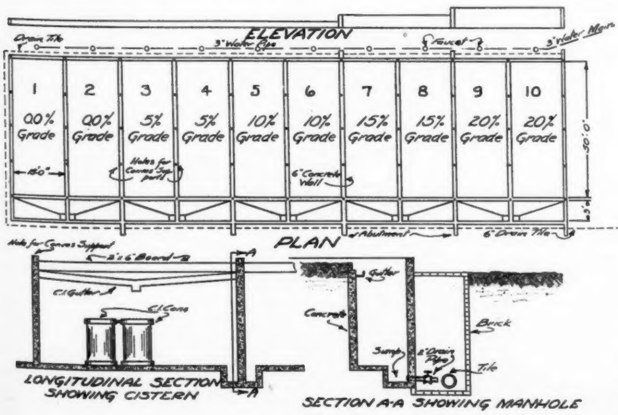
[2]Agricultural engineer, Alabama Agricultural Experiment Station. Mem. A.S.A.E.

[3]Research fellow in agricultural engineering, Alabama Agricultural Experiment Station.

[4]The erection of controlled field equipment and a large part of the work on the development of suitable methods of study was carried out by T. N. Jones, formerly fellow in agricultural engineering, Alabama Polytechnic Institute.

Table I. Factors Affecting Erosion

Soil Composition	Soil Structure	Surface Factors	Water Application
Absolute specific gravity	State of pulverization	Surface protection	Rainfall
			Amount
Size particle	Apparent Specific gravity	Surface shape	Rate
		Flat-contoured	Velocity impact
Colloid content			
Organic matter		Ridged-graded	Flood water
Moisture content	Flocculation	Slope	Amount
Chemical composition	Permeability		Velocity



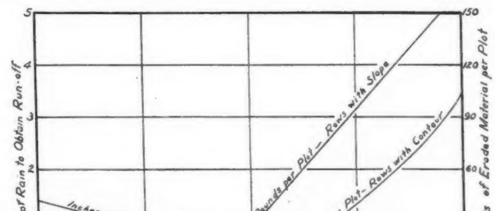


Fig. 1. (Left) Diagram of soil erosion plots used in studies conducted by Alabama Agricultural Experiment Station. Fig. 3. (Above) Curves show relationships between slope and runoff and between slope and erosion. The pounds of eroded material per plot were obtained by applying one inch of rain when plots were saturated

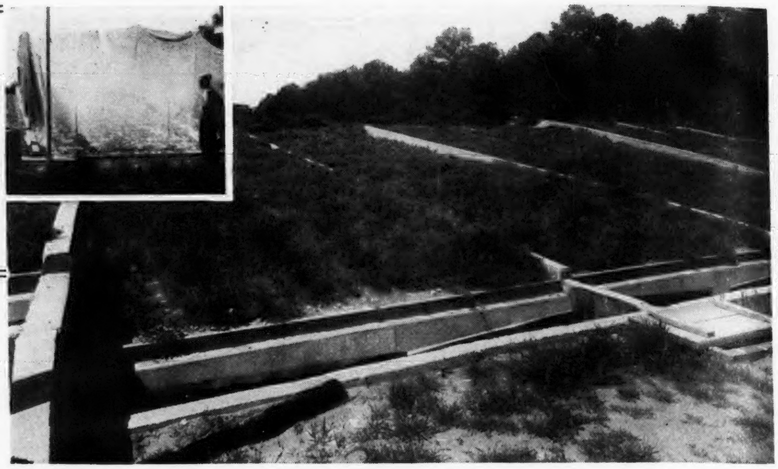


Fig 2. (Inset) The artificial rain system in operation as used in the Alabama soil erosion study. Fig. 4. This picture shows Soil Erosion Plots 5 to 10 with a growth of hairy vetch used as a soil-saving crop

connected to the 2-inch supply pipe with a 1-inch hose. A meter is used to measure the amount of water applied to the plots, and a stopwatch is used to determine the rate of application.

This rainfall system was adopted after careful testing of a large number of different spray nozzles. Tests of their properties were made by placing a large number of small pans at intervals over the plots, and measuring the amount of water falling in them.

While "rain" is being applied to one plot the adjoining plots are protected by a canvas 9½ feet high extending around three sides of the plot on which the "rain" is being applied. This canvas is supported by pipes placed in holes in the retaining walls.

Soil Used in Experiments. The soil used in the experiments is Cecil clay. To insure uniformity of soil on the different plots the surface soil and six inches of the subsoil were removed, and each thoroughly mixed, by piling and repiling, with tractors and slip scrapers. The soil was mixed by repiling twenty-one times. Mechanical analysis of each plot by the Robinson method showed a very high degree of uniformity. There was but one irregularity which could not be overcome. Plots 8, 9 and 10 required a three-foot fill at the upper ends to make the required grade. This fill was made, by careful tamping, to appear like the natural subsoil, but the effect of this fill has been apparent in the yields of crops for the two years of the experiment. This difference, however, has not greatly affected the erosion.

PRELIMINARY RESULTS

Effect of Rate of Rainfall. Studies of rainfall to date indicate that rate of rainfall is more important than the amount of rain in relation to erosion. Comparison of the erosive results of natural and artificial rains revealed the fact that this artificial rain system permitted a much better comparison of the effect of different variables than could be obtained by natural rains. Under natural conditions of rainfall it may rain at the rate of one inch in thirty minutes for ten minutes, then stop for a couple of minutes, then rain for the next half minute at the rate of one inch in two minutes, and then rain at the rate of one inch per hour and so on. Since the erosion varies as some power of the rate, the results obtained in terms of soil eroded under these conditions are confusing and almost impossible of interpretation. A recording rain gage is located immediately beside the plots. The results of natural rains have been recorded for the last two years and a number of attempts made to compare different rains. In some cases, under similar conditions of soil saturation and crop growth on the same slopes, ½ inch of rainfall produced greater erosion than ¾ inch of rain. Taking the average rate of rainfall helped to explain, but did not fully account for this difference. The kind of material lost also varied with different amounts and rates of rainfall. Sufficient data are not as yet available to establish the relationship of rate of rainfall and erosion, but the necessity of control is clearly indicated.

Effect of Moisture Content on Erosion. It is obvious that the degree of saturation of a soil affects its absorption and consequently the erosion. It appears that the moisture content not only affects permeability but also the dispersion of the soil at the time of the occurrence of the rain. This is an important factor in the kind of material lost. An example of this effect will suffice to bring out this point. One and one-half inch of rain was applied in 25 minutes to the plots having 5 per cent slope when the surface soil contained 10.78 per cent moisture. The run-off of the plot was 24.37 cubic feet and the soil eroded was 72 pounds per acre. On the same plot when the soil was saturated, the run-off for a similar rain was 64.87 cubic feet, and the material eroded per acre was 3,555 pounds.

Effect of Surface Shape Compaction and Coverage. All plots were planted to cotton in 1930. The plots having odd numbers were planted with the rows running up and down the slope and the plots having even numbers with the rows on contours. In the fall all plots were seeded to vetch and a heavy growth (Fig. 4) obtained in the spring. Each plot was then saturated and one inch of rain applied at a uniform rate in 8½ minutes. The run-off and soil eroded was then determined. As soon as the soil dried, the vetch was removed. The roots of the vetch were left in the soil and the tops removed carefully so as not to disturb the soil. The plots were then given a rain exactly like than put on the vetch, and the same determinations made. When the ground had again dried, it was plowed, raked smooth, and the rain again repeated. Table II shows the effect of these three rains. The tremendous saving of soil by the vetch is apparent, particularly when compared to the great loss of soil from plowed ground, which is similar to the common practice of plowing before the heavy spring rains.

The effect of running the rows up and down or across the slope is very marked. It is evident, even from the limited data available, that the practice of bedding has a very great effect on erosion, and that it should be considered in the development of any practical system of ero-

Table II. Effects of Various Common Practices on the Erosion Produced by a One-Inch Rain
(Results Shown in Pounds Per Acre)

Slope	0%		5%		10%		15%		20%	
	Rows run With slope	Con-tour	Rows run With slope	Con-tour	Rows run With slope	Con-tour	Rows run With slope	Con-tour	Rows run With slope	Con-tour
Land in vetch	63	94	80	65	90	82	569	268	604	284
Land bare	457	190	1093	193	1515	238	6733	2393	9256	5823
Land Plowed	610	623	2123	1995	2315	2427	9512	6294	19301	19000

Table III. Effect of Cultivation on Erosion with Different Slopes and Surface Shape

				Pounds Soil Eroded per Acre	
Slope, %	Rows	Moisture content, %	Run-off	Soil settled	Soil cultivated
0	with slope	11.49	46.88	84.68	
0	contour	11.85	45.95	82.94	
0	with slope	9.43	16.18		87.58
0	contour	9.65	16.22		117.16
5	with slope	10.64	83.81	673.96	
5	contour	10.38	75.00	705.86	
5	with slope	9.63	78.75		939.02
5	contour	8.64	65.62		661.78
10	with slope	9.60	91.88	25,909.76	
10	contour	10.85	84.37	19,151.60	
10	with slope	5.06	83.44		34,435.18
10	contour	7.48	78.88		21,377.64
15	contour	10.55	86.06	20,325.78	
15	with slope	5.75	91.13		69,323.34
15*	contour	8.59	80.63		36,485.48
20	with slope	8.15	93.75		73,773.36
20	contour	9.70	90.00		50,358.50

*Data from plots 8, 9, and 10 incomplete because of unavoidable break in water supply.

sion control. It is obvious that on the level plots all rows are on contours regardless of the direction of the rows. Since these plots were surrounded with low concrete walls, except on the side next to the cisterns, the water on Plot 1 ran off with the rows, and on Plot 1 it had to move across the rows to flow from the surface. This condition made the level plots comparable with the graded plots.

Effect of Cultivation. It has been shown in Table II that the rigidity of the surface layers of soil due to settling produce a resistance to erosion. These experiments were conducted under the conditions of a practically saturated soil. When the soil is dry, the effect is somewhat different. The air trapped in the soil appears to hinder absorption by cutting down the effective area of the water channels between particles, but the total absorption is greatly increased by shrinkage cracks and an increased capacity for moisture. Moreover, when the soil is broken up, rapid rainfall traps a large amount of air in soil floccules or fragments on the surface thus decreasing their apparent specific gravity and increasing their buoyancy.

To determine these effects the plots which were all in cotton were given a 2-inch rain in 18 minutes when they were very dry and determinations made of the run-off and material eroded. Following this the plots were again allowed to dry until all gravitational water had drained from the subsoil and the surface cracked open. The plots were then given a shallow cultivation and a rain of the same duration and intensity was applied. The results are shown in Table III. The erosion on the level plots was little affected by cultivation. It is apparent that the erosion increases with increased slope, and the losses suffered on a newly cultivated field increased in severity as the slope increased, being nearly 900 times as great on the 20 per cent slope as on the level plots when the water ran down the rows.

Effect of Erosion on Yield. The effects of erosion on yield are not easily determined in a short period of time, since many other factors affect yield. Table IV shows the results for one year. The yields on the 15 and 20 per cent slopes were noticeably large. This was attributed to three factors. First, there was a sufficient quantity of surface soil still left on the plots to produce a fair yield. Second, these four plots had a fill on the upper end which had not fully settled. This provided a storage for moisture during the season. Third, these plots warmed up earlier in the spring. This was the result of the natural drainage produced by the steep slope. The cotton came up quicker on these plots and was not overtaken in growth by the cotton on the other plots for several weeks. This effect was not so noticeable in the vetch yield as the vetch held the water on the soil.

Table IV. Yields of Vetch and Seed Cotton on Different Plots (1931)

Slope	0%		5%		10%		15%		20%	
	Rows run With slope	Contour	Rows run With slope	Contour	Rows run With slope	Contour	Rows run With slope	Contour	Rows run With slope	Contour
Pounds seed cotton per acre	1618	1940	1230	1510	966	1299	1010	1537	1744	2188
Pounds green vetch per acre	13470	18447	11281	14901	12248	13427	10678	14568	11508	13886

In every case the contoured rows produced greater yields than the rows running with the slope. This was probably caused by the increased absorption of these plots as much as by the erosion losses. The dividing walls between plots did not extend over 18 inches into the subsoil, consequently moisture held on the plots having contoured rows would seep under the walls into the plots having rows running up and down the slope. Moisture determinations showed this to be the case. Rows running beside the contoured plots gave a higher yield than the rows in the middle of the sloped-row plots. In every case, except in Plots 9 and 10, the row yields at the lower sides of the plots were much greater than at the upper sides of the plots.

Critical Slope for Cultivation. Fig. 3 shows the relationships between slope and inches of rain to obtain run-off, and between slope and the amount of erosion. It appears from this that the critical slope for this soil is in the neighborhood of 11 or 12 per cent. All experimental work done to date indicates breaks in the curves at this point in relationship curves, and it was concluded that this slope was the limit of slope for ordinary cultivation, or the point at which erosion losses become excessive. From field observation of various soils it appears probable that this point would be different for different soils. It would seem possible to determine what soil characteristics most affect this slope-erosion relationship. Correlation of these characteristics to critical slopes would make this work applicable to a wide variety of soils.

SUMMARY

Equipment for this study of erosion includes a series of plots of different slopes arranged to drain into cisterns where water and eroded material may be measured. The difficulties met in studying erosion by natural rainfall were overcome by an artificial rainfall system. Preliminary results obtained with the methods and equipment used indicate:

1. That rate of rainfall is one of the most important factors in the amount of erosion.
2. That the variations in rate of natural rainfall are sufficient to materially change the amount and kind of material eroded, even in storms of the same total duration and same amount of precipitation.
3. That degree of saturation of soil at the time of the beginning of precipitation materially effects erosion.
4. Erosion is materially reduced by contoured rows.
5. A heavy growth of vetch practically eliminated erosion on slopes up to 10 per cent during one inch of rain applied in 8½ minutes.
6. Plowing land materially increases erosion once the land becomes saturated. The increase is apparently a function of the grade.
7. Erosion varied uniformly with slope up to about 12 per cent grade. Above this slope, the rate of erosion increased very rapidly, and it was concluded that this was the critical slope for this soil.
8. Surface cultivation materially increases erosion when the rate of rainfall is high, and decreases erosion when the rate is low.

An Extension Program in Farm Machinery[1]

By J. T. McAlister[2]

CHANGES, the need of which has been quite evident to agricultural extension workers for a number of years, are now taking place rapidly in farming systems practiced in southern states. This is particularly true of South Carolina. With a system built around the one-mule plow as a power unit, it is quite natural that these changes should manifest themselves in improved methods of applying labor and power.

The agricultural extension service of Clemson Agricultural College is participating in this work through an organized project in farm machinery, which is divided into two sub-projects, one in power machinery and one in two-horse machinery. The power machinery work is being done on medium to large farms, those cultivating 150 acres or more; while the two-horse machinery project is designed for the large number of small farmers in the state. One of the objectives is to help the latter increase their labor incomes by using two-horse machinery for as many operations as possible.

In the power machinery work, farmers, who already own general-purpose tractors with planting and cultivating attachments, are selected by the county agents. A definite acreage of row crops such as cotton, corn and soybeans is set aside and all work is performed with the tractor and attachments. These are known as power-farming demonstrations, and a record book is furnished each cooperator in which a record is kept of all operations and costs. Thirty-one of these demonstrations are listed for 1931. Their location is confined mainly to the central or upper coastal plain section of the state. Farmers who are conducting these demonstrations are visited from time to time and assisted in adjusting and operating their equipment by the state extension agricultural engineer and the county agents. Since the equipment is new and often not well adapted to soil and local conditions, many problems have had to be met. The assistance of branch houses and local farm machinery dealers has been sought and obtained in most instances. In addition to visits a series of letters, giving detailed instructions on how to make adjustments and operate the equipment in the most efficient manner, is prepared and sent to all cooperating farmers, their local machinery dealers and county agents.

As another phase of the power machinery work we assist farmers who own combined harvester-threshers to obtain the desired results and handle their grain properly. There were sixty-six of these machines in operation in the state during the 1931 season. A number of owners are keeping records on harvesting costs and comparing them with methods previously used.

A large number of South Carolina farmers are making definite attempts to change their farming practices. They want to get away from the one-crop cotton system. In doing this they have bought tractors and other items of farm equipment, but, except in a few instances, the farm operator and the negro laborers have had little experience in operating any equipment larger than a one-mule plow. This has aroused the feeling of need, which the project in farm machinery has been launched to meet.

For three seasons since the work began a "power-farming tour" has been conducted to the various demonstration farms. A motorcade formed and county agents with interested farmers joined the procession at points along the way. From one to three days are used in visiting the result demonstrations. The tour affords an opportunity for the farmers to see first hand the equipment operating under actual field conditions and with the ordinary farm labor. This is usually more impressive than a staged demonstration where machinery service men do the operating. Last year the tour was held during the busiest season. While the attendance was not as large as on previous tours, those making the tour were able to see how those having power equipment get through the busy season. Cultivating row crops with both tractor and mule cultivators, combining grain, preparing grain land for soybeans and other crops, and planting soybeans were some of the major farm operations observed. Many of the farmers utilizing power equipment this season have done so as a result of the tours. Some stated that, when they saw their neighbors working with power equipment and ordinary labor, they became convinced of its practicability.

Numerous one-day method demonstrations have been held with two-horse cultivators and other two-horse machinery on farms where such machines have been operated with success. On these demonstrations the same kinds and types of sweeps and shovels that are used on single plows are used on the cultivators. This shows the farmer that he can double the amount of work done by one man and usually improve the quality of work. The result demonstrations with two-horse machinery are conducted on the same plan as the power-farming demonstrations. Farmers are asked to perform all operations on certain fields with two-horse machines and to keep cost records.

It is evident that county agents, local machinery dealers and representatives of machinery manufacturers must be acquainted with the program if it is to succeed. Accordingly several one-week schools have been held for county agents. At these schools opportunity was given the agents to familiarize themselves with the operation and adjustment of the more common machines that could be used in the state. Most of the agents have taken advantage of the schools. One school has been held for machinery dealers, as it is very necessary that they be better prepared to help farmers in obtaining the best use of their machines. Unfortunately, the program has not had the support that might be expected from branch houses and central offices of implement manufacturers. It is usually the local dealer that the farmer goes to when machinery troubles occur.

This is the third year the projects have been under way. The records being kept by farmers are measuring definitely the results being obtained. They show some reduction in production costs, which is of course one of the main objectives of the work. It is also noticeable from records and observation that farmers with power machinery are finding more uses for it and operating it more efficiently as they become familiar with it.

[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Birmingham, Ala., February, 1932.

[2]Extension agricultural engineer, Clemson Agricultural College. Mem. A.S.A.E.

Surface Irrigation in the East[1]

WHERE water can be taken from streams and carried to the land by gravity, large acreages often can be surface irrigated very cheaply. Unfortunately, conditions like this are rare in the East. On most eastern farms, it is necessary to pump the water from nearby streams or wells and deliver it through earth ditches or pipe lines to a convenient point where it is distributed by gravity through furrows or by flooding to the crops. The pumping plant is, therefore, an important part of most irrigation systems, whether the source of the supply be a well, stream, or pond. It seldom pays to pump water, for irrigation in the East, against a vertical lift of more than 100 feet for the ordinary field crops, although valuable truck or orchard crops have sometimes justified a lift of as much as 200 feet.

[1]From a radio-address by C. E. Seitz on "Irrigation in the Eastern States" broadcast from Station WGY.

Electric Motors for Farm Applications

By B. W. Faber[1]

CONSIDERABLE misinformation exists relative to small electric motors, their characteristics and application to farm equipment. This paper is intended, therefore, as a guide to farm electrification service men and others who apply and install electric motors on farm equipment.

Motors are of two general classifications—alternating-current and direct-current motors. We are not greatly concerned with direct-current motors since they are used principally in connection with farm light plants and are usually sold as an integral part of the complete equipment.

Alternating-current motors are either "single phase" or "polyphase." "Single phase" motors of six types: (1) Split-phase, (2) repulsion-start-induction-run, (3) repulsion-induction, (4) straight repulsion, (5) series, and (6) capacitor. "Polyphase" motors of three types: (1) Squirrel cage, (2) wound rotor, and (3) synchronous.

The chief difference between these motors is in their operating characteristics. The difference in cost of each particular design is also an important factor. Operating characteristics of motors involve such factors as starting torque, break-down torque, pull-in torque, starting current, running current, power factor, efficiency, etc., a short explanation of which will help to explain the operating characteristics of motors in general.

Starting Torque. Starting torque is, as the name implies, the torque a motor is able to exert to start a load. This torque is usually higher than the full-load torque of the motor and is required to overcome static friction and accelerate the load to full speed in the required time. The starting torque required on some applications is very low, such as fans and blowers. On the other hand, such applications as plunger pumps, compressors and cream separators require a high starting torque.

Break-Down Torque. The break-down or pull-out torque of a motor determines its momentary overload capacity. When the load imposed on a motor exceeds its breakdown torque, it either pulls out in the case of polyphase motors, or drops back to the starting condition in the case of split-phase or repulsion-start motors. In the latter case the speed has to drop to a point where the centrifugal device comes in. If the overload persists, and the motor is not taken off the line either by hand or by automatic protection, serious damage will result.

Pull-In Torque. The pull-in torque of a motor is the torque available when the motor load is transferred from the starting to the running winding. Fig. 1 shows a typical repulsion-start-induction-run motor curve. The pull-in point is somewhere near point "B". With the centrifugal device (also called short-circuiter) transferring the load from the starting to the running winding at this point, the motor will come up to speed on the induction curve. This transfer point is usually at about three-fourths full-load speed. If the centrifugal device operates below the point at which the repulsion curve crosses the induction curve, the motor may or may not come up to speed depending upon the torque required by the load. If the torque required is lower than that which the motor can exert on the induction winding, the motor will pull-in and come up to speed.

Starting Current. In starting its load a motor momentarily draws more current from the line than for the normal operating condition. This is referred to as the starting current. This extra current is drawn from the line only for the short period required for the motor to start, and where the transformer has sufficient capacity with ample size of wiring used between the transformer and the motor, there should be no objectionable voltage drop.

Power Factor. The power factor of alternating-current motors is a very important item. Poor power factor is the result of so-called "wattless" or magnetizing kilovolt-amperes which is not measured by the ordinary wattmeter, but does require added transformer capacity and larger wire. The power factor of an alternating-current motor can be determined by reading from suitable meters the watts input, the volts, and the amperes, and then dividing the watts input by the product of the volts and amperes. Some useful motor formulas are as follows:

In an alternating-current, single-phase motor

$$\text{Horsepower} = \frac{\text{voltage x current x power factor}}{746}$$

In an alternating-current, three-phase motor

$$\text{Horsepower} = \frac{1.73 \text{ x voltage x current x power factor}}{746}$$

There is a definite relationship between torque, horsepower, and speed, expressed as

$$\text{Horsepower} = \frac{\text{torque x revolutions per minute}}{5250}$$

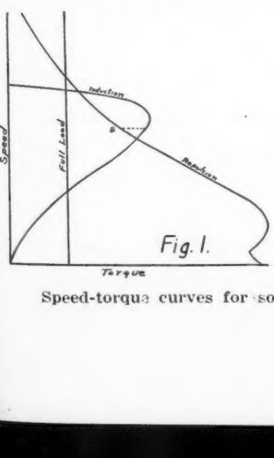
In this latter formula, torque (this is the turning effort which the motor exerts on its shaft) would be expressed in pound-feet. Torque is usually expressed in pound-feet in connection with integral horsepower motors, and is expressed in ounce-feet in connection with fractional-horsepower motors. When torque in ounce-feet is used, the figure 5250 in the above formula becomes 84,000.

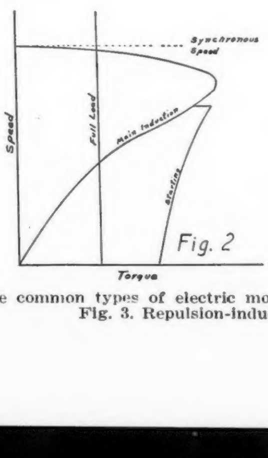
One pound-foot of torque is a force of one pound acting at a radius of one foot. Likewise, one ounce-foot is a force of one ounce acting at a one-foot radius.

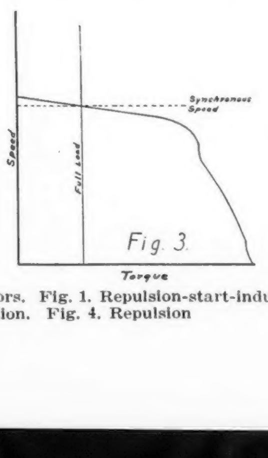
CHARACTERISTICS OF SINGLE-PHASE MOTORS

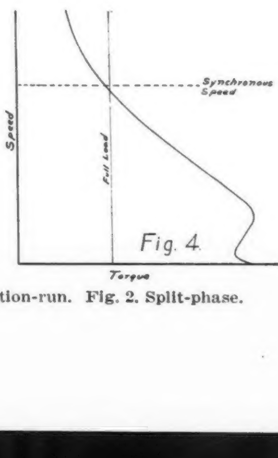
Split-Phase Motors. Split-phase motors are designed and built for commercial frequencies and voltages (110 and 220 volts). A separate motor is required for each voltage. Split-phase motors are available in ratings of ¼ horsepower and smaller. There are some manufacturers who

[1]Farm electrification engineer, Westinghouse Electric & Manufacturing Company. Mem. A.S.A.E.









Speed-torque curves for some common types of electric motors. Fig. 1. Repulsion-start-induction-run. Fig. 2. Split-phase. Fig. 3. Repulsion-induction. Fig. 4. Repulsion

furnish split-phase motors in ⅓ horsepower rating, but the high starting current is frequently objectionable.

Under no conditions should a split-phase motor designed for 110-volt service be connected to a 220-volt line because the higher voltage would quickly burn the windings out. A 220-volt motor operating on 110 volts will have less than one-half the output which would be obtained on 220 volts.

The usual method of starting a split-phase motor is by means of an auxiliary winding which has high resistance and low reactance as compared with the main winding. The starting winding is connected in parallel with the main winding. A centrifugal switch opens the starting circuit after the motor has reached a predetermined speed. The starting winding can be located and tested by lighting out the circuit with the starting switch opened and closed.

The starting torque of a standard split-phased motor is usually about 1¾ times full-load torque, with the breakdown torque being about 2½ times full-load torque. (See Fig. 2.) The starting current may be as much as five to seven times full-load current, depending upon the amount of starting torque required and the maximum torque for which the motor is designed.

Standard split-phase motors are designed for applications requiring only normal torques. They are used on applications such as washing machines, dishwashers, portable tools, fans, blowers, grinders, etc.

To change the direction of rotation of split-phase motors —with the binding post type of construction—either the leads of the starting winding or the leads of the running winding should be interchanged. Both windings should not be interchanged. On motors having only two leads coming out of the frame, it is necessary to interchange connections inside the motor.

Repulsion-Induction Type Motors. There are three distinct designs of single-phase, alternating-current commutator type motors which are sometimes confused, since they are all classed as repulsion-induction motors. They are (1) repulsion-start-induction-run, (2) repulsion-induction, and (3) repulsion.

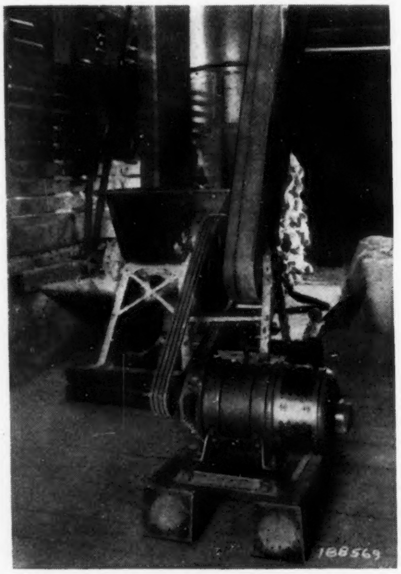
The repulsion-induction type motors are dual voltage motors, the windings being connected in series for 220-volt operation, and in parallel for 110-volt operation. Motors for commercial frequencies are available.

Single-phase, repulsion-induction motors are available in comparatively large ratings, but rural lines are usually limited to 5 and 7½-horsepower motors.

Repulsion - Start - Induction - Run Motors. For starting, this type of motor employs a centrifugal device which short-circuits the armature at a predetermined speed and allows the motor to operate as an ordinary single-phase induction motor. Fig. 1 shows characteristic curves for this type of motor. As can be seen from the curves, the short-circuiting device operates at about three-fourths full-load speed.

As the repulsion - start - induction-run motor speeds up on the repulsion winding, the torque increases and the short-circuiting device is usually set to operate just above the point (Fig. 1) at which the repulsion and induction speed-torque curves cross. It is desirable that the available torque increase immediately after the short-circuiting device has operated, to insure that the torque will be sufficient to bring the load up to speed.

The starting torque of a repulsion-start-induction-run motor is approximately four times full-load torque in sizes of one horsepower and below and from 3½ to 4 times in the ratings above one horsepower. The pull-out torque is from 2 to 2½ times full load. The starting current is usually about 3 to 4 times full-load current. Thus the starting current can be seen to be lower than for split-phase motors with corresponding greater torques.



A 7½-hp. electric motor driving a feed grinder and mixer on the Pennsylvania State College farm

This type of motor is used on such applications as compressors, pumps, conveyors, feed mills and general-purpose applications. In the fractional-horsepower sizes this type of motor is frequently used in preference to the split-phase motor because of its better operating characteristics, even though the latter has a lower cost.

To change the direction of rotation of this motor, loosen the brushholder and rotate brushholder ring to opposite side of electrical neutral. Markings will show how far to rotate this ring.

Repulsion-Induction Motors. The repulsion-induction motor is similar to the repulsion-start-induction-run motor with the exception that the armature contains a squirrel-cage winding in addition to the regular repulsion winding and does not employ any centrifugal or short-circuiting device. This type of motor has the brushes riding on the commutator at all times. Because of this two-winding arrangement the power is exceptionally high. It has the ability to maintain its speed at low voltage, this not being true of the repulsion-start-induction-run motor.

By comparing Figs. 1 and 3 considerable similarity can be seen in the speed-torque curves. The starting and pull-out torques are somewhat higher with the repulsion-induction motors. Note from the curve that under light load conditions the motor operates above synchronous speed.

These motors are used for general-purpose applications similar to those given for the repulsion-start-induction-run motor.

The direction of rotation is changed the same as in the repulsion-start-induction-run motors.

Repulsion Motors. The repulsion motor may be said to be a repulsion-induction motor without a centrifugal device. Fig. 4 shows the speed-torque curve for this type of motor. It can be noted that speed regulation is poor, and the motor has a high no-load speed.

The starting torque for this type of motor is similar to the other types of repulsion-induction motors.

The chief advantage of this motor is that it is capable of speed reduction or control by using the correct variable-speed resistance in the line circuit. Some speed control can also be obtained by shifting the brushes on the commutator.

The repulsion motor can be used where variable speed is required, as for fans, blowers, conveyors and similar equipment.

Series Motors. Universal or series motors are built for definite voltages in ratings up to one horsepower. They are available for 110 volts, alternating or direct current, and for 220 volts, alternating or direct current. Each voltage requires a separate motor although there are instances where a resistor is used in series when a 110-volt motor has to be operated on 220 volts. These motors are available in the lower fractional-horsepower ratings.

For starting, the field and armature of this motor are connected in series. No centrifugal device is used. The brushes ride the commutator at all times.

The starting torque is comparatively high being about 2 to 2¼ times full load.

Universal motors operate at comparatively high speeds and are used mostly for portable appliances, such as portable drills, wood-working tools, vacuum cleaners, drink mixers,

small blowers and fans, motion picture machines, paint sprayers, sewing machines, etc.

To change direction of rotation of this motor, the brush-holder leads are reversed. On some makes of motors the reversing connections are made under the name plate, otherwise the reversing is done inside the motor.

Capacitor Motors. The capacitor motor has more varied designs and combinations than any other type of motor on the market. It is essentially a two-phase motor operating from a single-phase line, with a capacitor unit in series with one phase of the motor. The main phase and the capacitor phase are connected to the line in parallel. This motor has an unusually high power factor, and in this respect resembles the repulsion-induction motor.

There are three classes of capacitor motors: (1) Single-value capacitor, (2) capacitor-start-induction-run, and (3) two-value capacitor.

The single-value capacitor motor starts and runs on the same value of capacity; its starting torque is usually less than full load; it is used for fans, blowers, some types of oil burners, and similar devices; and it is usually quiet in operation.

In the capacitor-start-induction-run motor the capacitor is cut out by a centrifugal device after the motor has come up to speed; its operating characteristics are similar to those of the repulsion-start-induction-run motor; the starting currents are low, and it is used to drive compressors, pumps, refrigerators, etc.

The two-value capacitor motor starts on one value of capacity, and is transferred to another value by a centrifugal switch; and it has a high power factor, and good torques with low starting current.

Capacitor motors can be designed for various ratings although at the present time the ratings usually found are below one horsepower, except for very special applications. The cost of capacitor motors in ratings below ¼ horsepower compares favorably with repulsion-induction motors. In ratings above ¼ horsepower a point is reached where the amount of capacity necessary makes the cost prohibitive, except where its increased power factor, efficiency, etc., may make it more desirable than other types of motors.

CHARACTERISTICS OF POLYPHASE MOTORS

Where the power demand is such that power units of 10 horsepower or larger are needed, polyphase motors are frequently installed. As a general rule, they are three-phase motors, and their direction of rotation may be reversed by interchanging any two of the leads. They may be divided into three classes: (1) Squirrel cage, (2) wound rotor, and (3) synchronous.

Squirrel-Cage Motors. The squirrel-cage motor has no commutator or brushes and no short-circuiting device. They are referred to as the simplest of all types of motors.

These motors are divided into standard and high-reactance types. The high-reactance motors can be divided into two other types, namely, the deep-bar type for normal starting torques, and the double-deck type for applications requiring a starting torque of two or more times normal torque.

The rotor cage may consist of either copper or brass bars with end rings, or it may be entirely of cast aluminum.

The standard squirrel-cage motor has average torque, which is about 1½ times full-load torque. The high-reactance squirrel-cage motor is similar to the standard squirrel-cage motor, except, that it draws lower current from the end when starting. These motors are used where starting requirements are not severe.

The double-deck squirrel-cage motor has two separate windings on the rotor giving a starting torque of about 200 to 250 per cent of normal, with a pull-out torque approximately the same as for the standard motor. It draws less current from the line while starting than the standard motor.

The double squirrel-cage motor is used on pumps, compressors, and similar equipment where the starting torque requirements are comparatively high.

Wound-Rotor Motors. The chief difference between the squirrel-cage and the wound-rotor motors is primarily in the rotor. Instead of the regular squirrel-cage winding, the rotor is coil-wound with the end of each series of windings being brought out to a slip ring.

Variable resistance may be inserted in series with the rotor on wound-rotor motors. This is made possible by the slip rings and brushes. The resistance is used to reduce the starting current and obtain proportionately higher starting torques. Variable resistance is also used to obtain speed control for such applications, such as conveyors, hoists, etc.

Wound-rotor motors are used for driving compressors, pumps, conveyors, and so forth.

Synchronous Motors. A synchronous motor operates at only one speed regardless of load or voltage, each motor, of course, being designed for a particular voltage. Most synchronous motors also have an induction winding on the rotor which furnishes the power to bring the motor up to speed, at which time the synchronous winding pulls it into step. This synchronous speed depends on the number of poles in its field and the frequency of the power source. The power factor of this motor can be made to vary widely, even leading.

Ditch Maintenance[1]

ANOTHER phase of drainage work that is always in need of attention is that of ditch maintenance. Systematic annual maintenance is, as a general rule, indispensable if a drainage ditch is to continue to function efficiently. Small ditches draining small watersheds require more attention than do large ditches draining large watersheds, and ditches in comparatively flat country—such as central Illinois and the delta of Mississippi and Arkansas — require more attention than ditches in a country with rolling and hilly topography where the water courses have greater fall. Large ditches draining hilly watersheds are, to a considerable extent, self-maintaining because there is nearly always a fairly large low-water flow which prevents growth on the bottom and on the lower part of the side slopes, and there is generally sufficient erosion and caving to prevent growth on the upper portions of the side slopes. Large ditches in flat country do not as a rule require much maintenance because there is nearly always a fairly large low-water flow and, even though the flow is small, there is generally sufficient velocity of flow to keep the channel in fairly good condition.

It is the comparatively small ditch in a flat country that requires the most attention. Such ditches often go dry during the summer, and thus afford a good opportunity for vegetation to spring up from seed on the bottom of the ditch. The more fertile the soil the more rapid the growth. The fall along the ditch is small, so the velocity is not sufficient to produce erosion but generally permits the deposit of rich soil laden with plant seeds which produce growth at the first opportunity. The small ditches in the delta of Mississippi and Arkansas, and especially those in central Illinois and northern Ohio, exemplify these conditions.

To properly maintain the capacity of such drainage channels, it is essential that they be cleared of brush and wood growth each year. It is indeed short-sighted policy that permits the construction of drainage ditches without provision for maintaining them. One of the most important problems facing drainage engineers today is that of developing economical methods of maintaining drainage improvements after they have been constructed. The Bureau of Agricultural Engineering of the United States Department of Agriculture, in cooperation with the State of Delaware, has recently started investigations to determine the most economical means of maintaining the five-hundred miles of drainage ditches in Kent County, Delaware. It is hoped that these investigations will yield information that will be of general value in drainage work.

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[1]From a paper on "Present Needs in Drainage Work," by Lewis A. Jones, presented before the National Drainage, Conservation and Flood Control Congress at Louisville, Ky., February, 1932.

Size of Rooms in Architects' 5-Room Houses[1]

By Dan Scoates[2]

WHILE THE TITLE of this article indicates that this is an analysis of "architects' plans," I do not mean to infer that the plans analyzed for ready-cut houses in the previous article of this series were not planned by architects, but this method of differentiating between the two sets of plans analyzed seemed to be the best. The plans analyzed in this group consisted of those put out by the Architects' Small House Service Bureau, Inc., and other similar recognized plans. There were 128 plans in all.

The following paragraphs indicate the three most prevalent room areas in each plan and the three most popular dimensions under each one.

Kitchens. There was a kitchen in each of the 128 plans analyzed. The figure shows the way the various sized kitchens were distributed through the scale of area sizes. The most popular areas and dimensions were

1. Area, 90 to 99.9 square feet—9x11, 8x12¼, and 9x10 feet.
2. Area, 100 to 109.9 square feet—8x12½, 8½x11, and 9x12 feet.
3. Area, 110 to 119.9 square feet—10x11, 9x13, and 9½x11 feet.

Dining Rooms. There were 111 dining rooms in the 128 house plans. The distribution of areas of these are shown in the figure, in which the most prevalent areas and popular dimensions are

1. Area, 140 to 149.9 square feet—11x13, 11½x12½, and 10x14 feet.
2. Area, 150 to 159.9 square feet—12x13, 11x14, and 11x14¼ feet.
3. Area, 170 to 179.9 square feet—13x14 and 12x15¼ feet.

Living Rooms. Each plan analyzed had a living room. The figure shows how the areas were distributed. The most popular areas and the most prevalent sizes in dimensions are

1. Area, 240 to 249.9 square feet—13x19, 13½x18, 11¾x20¾ feet.
2. Area, 260 to 269.9 square feet — 13x20, 13x20½, and 15x24½ feet.
3. Area, 280 to 289.9 square feet—13½x22½, 14x20, and 13x21 feet.

Bedrooms. There were 256 bedrooms in the 128 plans, the areas of which are shown in the figure. The most popular areas and sizes are

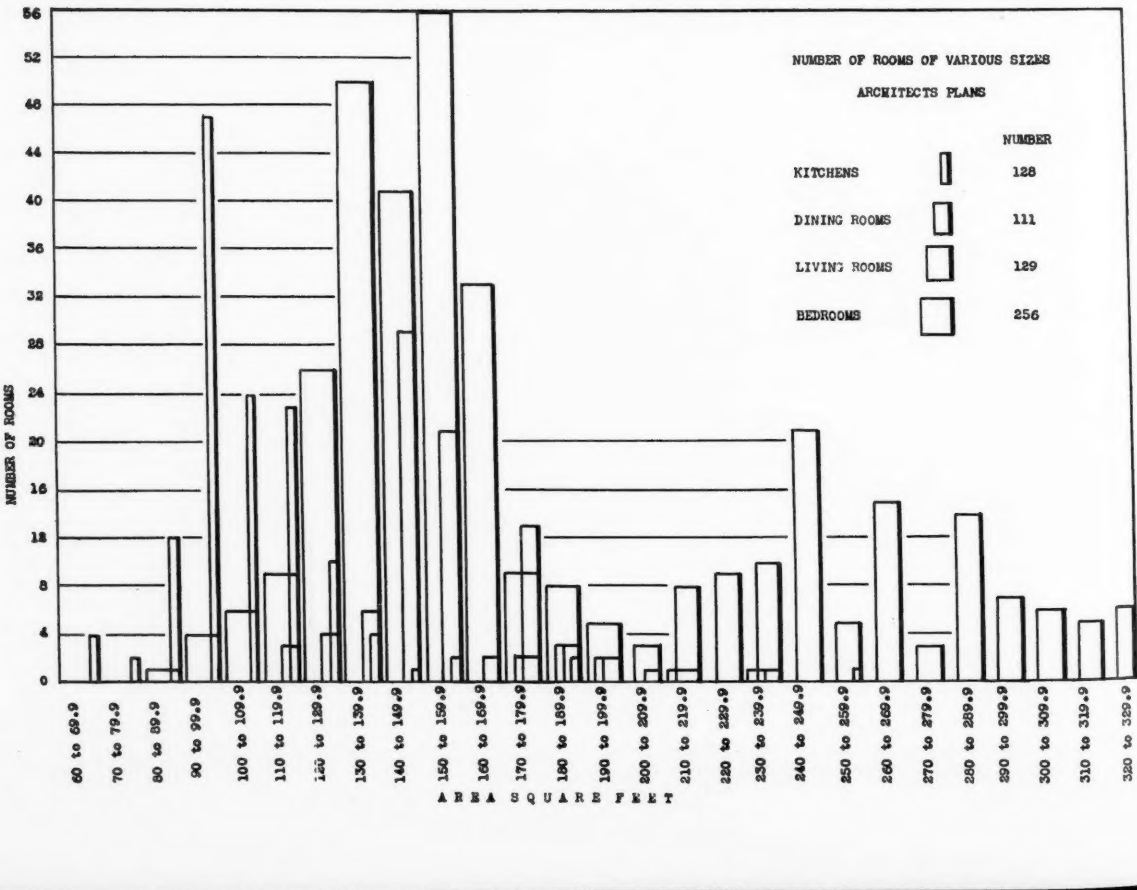
1. Area, 150 to 159.9 square feet—12x13, 11x14, and 12x12½ feet.
2. Area, 130 to 139.9 square feet—11x12, 10x13, and 11x12½ feet.
3. Area, 140 to 149.9 square feet—11x13, 11½x13, and 12x12 feet.

In comparing the results of this study of size of rooms used in the architects' plans with those used by the manufacturers of ready-cut houses, and with those found in farm homes, it is found that the architect uses sizes intermediate between the other two groups.

It will be noted that practically all the rooms are rectangular in shape. Many of them are odd feet to allow for wall spaces, and thus the use of even feet joists and other lumber members.

[1]Fourth of a series of articles presenting the results of an engineering investigation of farm house sizes and design.

[2]Professor of agricultural engineering, A & M College of Texas. Mem. A.S.A.E.



Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Heat Transfer Through Building Walls, M. S. Van Dusen and J. L. Finck ([U. S.] Bureau of Standards Journal of Research, 6 (1931), No. 3, pp. 493-522, figs. 15).—A method is described for measuring the heat transfer through large flat slabs such as wall sections, under laboratory conditions, and the results of tests are given for a number of typical walls. The method requires no actual measurement of heat flow over large areas, but consists in comparing the thermal resistance of an unknown panel with a standard, the resistance of which can be accurately determined by the hot plate method.

The test results indicate in general that the presence of air spaces or pockets increases the insulating values of walls built of heavy clay products. Furring materially increases the insulating value of ordinary types of walls. It appears that the differences in insulating value between the various types of hollow tile walls tested are unimportant, and this applies also to different kinds of brick. The type of workmanship in a masonry wall may materially affect the insulating value, depending chiefly on the filling of the mortar joints. Solidly filled vertical joints are not so effective from the insulation standpoint as partially filled joints. It was found that the insulating values of all walls tested increased with decreasing temperature, the increase in general being more rapid with hollow walls than with solid walls.

Correlation of Certain Soil Characteristics with Pipe-Line Corrosion, I. A. Denison ([U. S.] Bureau Standards Journal of Research, 7 (1931), No. 4, pp. 631-642, figs. 4).—The results of investigations are reported which indicate that corrosion which has been experienced on a group of pipe lines in Ohio may be attributed to the corrosiveness of certain soils occurring along the lines. A satisfactory correlation was found to exist between the exchangeable hydrogen present in the soils and corrosiveness, as indicated by the quantity of pipe replaced. In addition an accelerated laboratory test of soil corrosiveness involving the corrosion of a steel disk in contact with moist soil is described.

The results obtained by this method paralleled the quantity of pipe replacements fairly closely in the case of heavy soils. The degree of corrosiveness indicated by the test is influenced by the acidity, texture, and probably by the structure of the soils studied.

[Agricultural Engineering Investigations at the Missouri Station] (Missouri Station (Columbia) Bulletin 300 (1931), pp. 36-46, 97, figs. 7).—Data are reported by J. C. Wooley on the relation between the investment in service buildings and the value of farm land, based on a survey of the farms in Nodaway County, Mo. These indicate the investment in farm buildings and its contribution toward the farm income, and show that the annual cost of service buildings on these farms is 5.79 per cent of the cost of production.

Studies of electric refrigeration for farm dairies by R. R. Parks and M. M. Jones made on 16 farm dairy refrigeration plants showed that the first cost of the refrigeration plants varied from $555 to $1,750 per 100 gallons daily capacity. The wet storage type of system was cheaper than the dry type. The larger systems were cheaper per 100-gallon capacity than small ones. Homemade cold storage rooms were generally cheaper than those bought ready made. The type and quantity of insulating material used in the walls also affected the cost. The addition of accessories increased the first cost in some cases.

Operating cost ranged from 0.09 to 0.48 kilowatt-hour per gallon of milk cooled. Energy consumption was affected by the temperatures to which the milk was cooled and stored and the quality of insulation on the storage room or tank. Under average conditions, an energy consumption of 0.10 to 0.15 kilowatt-hour per gallon of milk cooled and stored was considered good.

Air-cooled compressors and condenser coils were usually to be recommended rather than water-cooled machines. Where only wholesale milk was produced and the milk sold in cans, a wet type tank met the requirements for both the precooling and the storage. Usually there was a lower bacteria count in milk where it was cooled in cans in a wet storage tank rather than precooled over an aerator and then stored. Dry storage was generally preferred for the retail dairy where the milk was sold in bottles.

Data also are reported on filling silos with a 5-horsepower motor, underheating for electric brooders and heating hotbeds with electricity. It was found that electrically heated hotbeds were practical and economical where electrical energy was available at from 2 to 3 cents per kilowatt-hour or less and where manure was relatively expensive. The heat and rate of growth can be better controlled in electric hotbeds than with manured beds.

M. F. Miller and H. H. Krusekopf reported that in the soil erosion experiments at the end of 12 years the losses from land in continuous corn have been almost 7 times as great as the losses from land on which a good crop rotation has been followed and almost 50 times as great as that from bluegrass sod. Land plowed 8 inches deep has eroded somewhat less than that plowed 4 inches deep.

Four years' data indicate that on the plats in continuous corn the loss per unit area has been less with increasing length of slope. The loss from a slope of 8.48 per cent has been 0.92 surface inch annually, as compared with 0.50 surface inch from a 6 per cent slope and 0.13 surface inch from a 3.68 per cent slope.

The Electric Cooking Load (Engineer [London], 148 (1929), No. 3848, p. 389, fig. 1; abs. in Sci. Abs., Sect. B—Elect. Engin., 33 (1930), No. 386, p. 108, fig. 1).—A special type of electric cooking stove is described and illustrated which overcomes the difficulty of short-period consumption of electricity. The maximum energy consumption is from 450 to 600 watts, and the operation depends on air circulation produced by a small fan. The heat reservoir is a cast-iron core in which the electric heating element is inserted. The core is surrounded by sand which is held in place by a perforated cover, the whole being inclosed in an air-tight sheet-iron casing. The principle of the apparatus is that if a wall at the temperature of the surrounding air is electrically heated on one side, a certain time will elapse before the temperature begins to rise appreciably on the other side. If the heating process continues, a definite and uniform temperature is established on both sides of the wall.

[Agricultural Engineering Investigations at the Idaho Station] (Idaho Station (Moscow) Bulletin 179 (1931), pp. 14-17).—The irrigation investigations of the station are briefly summarized, indicating among other things the feasibility of combined drainage and irrigation pumping from the same wells. It appears also that greater yields may be secured from plats of beans irrigated in each row than from plats irrigated in alternate rows.

The land reclamation studies, conducted in cooperation with the U.S.D.A. Bureau of Agricultural Engineering, have shown that the prevention of alkaline soil conditions by means of effective drainage will be more satisfactory than the attempted reclamation of soils after they have become alkaline.

In studies of power machinery it has been found that the use of the combine for the direct harvest of peas is one of the important applications of this machine, both from the saving of peas due to the elimination of shatter, which occurs under other methods, and the possible control of the pea weevil, which is aided by the early removal of the peas from the fields.

Experiments on the operation of farm equipment with electric motors showed that a combination of V-motor drive and flat-driven pulley gave the lowest energy consumption in silo filling.

In studies of poultry houses a comparison of the insulated and uninsulated brooding and laying houses has shown very little difference in the maximum and minimum temperatures reached. The rate of change of temperature, however, is much slower in the insulated house and for that reason tends to produce more desirable living conditions.

Roof Exposure Tests of Outside White Paints (U. S. Department of Commerce, Bureau of Standards Technical News Bulletin 156 (1930), p. 33).—It is reported that during the past six years a large number of laboratory-made white paints have been subjected to weathering tests. The paints have been applied either in three coats on carefully selected wood panels or in two coats on thoroughly cleaned metal panels.

The results observed indicate that pure white lead paints are satisfactorily durable. Lead-zinc paints, with zinc oxide contents not exceeding 30 per cent, are also satisfactory. An increase of the zinc oxide content to 50 per cent, however, results in cracking and scaling in paints on wood panels. On metal, lead-zinc paints (zinc oxide content not exceeding 30 per cent) are better rust preventives than are pure white lead paints. Titanium-zinc paints, provided that the zinc oxide content does not exceed 30 per cent, are weather resistant and remain clean and white longer than do lead-zinc or white lead coatings.

After three years' exposure titanium-zinc paints, some containing a mixture of titanox, zinc oxide, and white lead, are giving good results. Among the best of these is a mixture of titanox 45 per cent, zinc oxide 20 per cent, and white lead 35 per cent, this coating being free from cracks and having worn, by slight chalking, to a smooth, clean surface. Increase in the zinc oxide content, while retaining the ratio of the other constituents, results in cracking. Pure titanium oxide, calcium titanox, and barium titanox paints chalk excessively.

The vehicle used in these paints consisted of 60 parts raw linseed oil, 20 parts heavy-bodied linseed oil, and 20 parts turpentine and drier.

The Determination of Animal Work Accomplishment in Agriculture Through Power Measurements and the Results Thereof, G. Lipinski (Die Landwirtschaftlichen Versuchs-Stationer (Ber-

lin), 112 (1931), No. 3-4, pp. 191-242, figs. 11).—In a contribution from the University of Breslau several different types of draft dynamometers are described, and the results of draft measurements, using three of them, are reported of drills, fertilizer distributors, harrows, mowers, potato diggers, cultivators, plows, tractors, rollers, wagons and choppers.

A 1,000-kilogram hydraulic draft dynamometer was found to be best adapted for tests of this character and to yield what appeared to be the best average results.

It was found that the horses of a 2-horse team will vary considerably in their draft output. On down-grade work the pull on tongue chains also is considerable, making brakes on implements, used in hilly country, necessary to conserve horse energy. The necessity for lubrication of machines also was emphasized in the draft results, it being found in one case that a wagon had four times the draft with ungreased axles as with greased axles.

The tests also revealed that the output in work of horses used in Germany is only average, and it is felt that a greater output can be obtained from them.

Compressive and Bending Tests on Solid and Built-Up Wooden Struts [trans. title], O. Graf (Forschungsarb. Geb. Ingenieurw., No. 319 (1930), pp. [2] + 14, figs. 86; abs. in Ztschr. Ver. Deut. Ingen., 74 (1930), No. 4, pp. 121, 122, figs. 13; [Gr. Brit.] Dept. Sci. and Indus. Research, Bldg. Sci. Abs., n. ser., 3 (1930), No. 4, p. 134).—Data are reported which were obtained from compressive and bending tests on solid and built-up wooden struts. It was found that the elastic modulus of soft woods free from knots varies between 140,000 and 70,000 kilograms per cubic centimeter (between 890 and 445 tons per square inch). It is recommended that compression tests be carried out on square prisms three times their width in height and of a size appropriate to practical conditions.

Comparative bending tests on solid and laminated beams showed that the friction on which the horizontal shear resistance of the latter depended was not constant, and that bolted connections were not sufficient to develop the full strength of a solid beam of the same material and dimensions. The effects of various methods of connecting the longitudinal members and of the slenderness ratio are illustrated by curves.

The Plasticity of Clay, I, II (Ceramic Society (Columbus, Ohio) Transactions, 29 (1930, No. 5, pp. 177-207, figs. 15; 208-216, figs. 3; abs. in [Gr. Brit.] Dept. Sci. and Indus. Research, Bldg. Sci. Abs., n. ser., 3 (1930), No. 5, pp. 156, 157).—This report consists of two parts.

I. **Mechanical methods of measurement,** S. R. Hind—In this part of the report a critical survey of the literature on the mechanical testing of plastic clays is given. Mellor's data on the effect of pressure on stickiness were found to agree with the expression $A = 2.78 + 0.00437\ P^{2\cdot 2}$, where **A** is the ratio of weight of clay to weight of water and **P** is applied pressure in kilograms per square centimeter. This may be interpreted to mean that the pressure required is dependent on the relative amount of water in the clay surface.

Tests on the axial compression of rectangular plastic clay blocks showed that resistance to deformation increased progressively with deformation in a manner which could not be accounted for by increased cross-section. The retraction consequent on reducing the load was demonstrated and shown to be practically uninfluenced by the previous deformation suffered by the clay. The plastic deformation of clay, whether under axial compression or tension, was considered to resolve itself principally into shear or slipping of the clay in layers.

Experiments on the intermittent loading of test pieces in tension were shown to bear out the main conclusions to be derived from previous tests. A suitable technic for this class of test is described and results given for different classes of clays, plasticene, and ball-clay rape-oil mixture.

Extensive experiments were conducted on the extensibility of a standard clay, on which much collateral data is available, under conditions of automatically increasing load. By molding the test piece directly in end pieces, providing it with a pre arranged neck at which plastic distortion took place, providing means whereby the molded test piece was transferred to the testing position without contact with the hands or relative movement of the end pieces, and by carrying out the experiments in a saturated atmosphere at 20 C, it proved to be possible to obtain close agreement between tests. The stress strain diagrams, up to a point at which incipient fracture was deemed to interfere, were susceptible to simple mathematical expression. Thus $L \times (B' \div C) \sqrt{E}$ was found to be in general agreement with the data, **L** being the load, **E** the amount of extension, $(B' \div C)$ a softness factor, in which **B'** was peculiar to the clay and the shape, etc., of the specimen, while **C** was the rate of loading.

The softness factor was determined for the given clay with all workable moisture contents, and a further simple relation found to apply to the whole range of stress strain diagrams, viz: $(M - M_0)^2 = P \sqrt{(E \div L)}$ where **M** is the moisture content of any specimen, **E** its extension under the load **L**. The constant M_0 gives the lower limit of plasticity for hand working, and **P** represents the way in which softness increases with increase in moisture content.

No indication was obtained that any combination of factors which might be termed "plasticity" attained a maximum at the state known as the best working consistency. It was shown that the ultimate tensile strength and extensibility were simply related to the softness factors and that these were in consequence related to all the plastic behavior of the clay within the limits of the experimental procedure. Methods by which the survey of the plastic properties of clay might be carried to a logical conclusion were suggested. A bibliography of 23 references is appended.

II. **The effect of non-plastic additions on the mechanical properties of a plastic clay,** S. R. Hind and E. P. Degg—Experiments based on a method and apparatus designed by one of the authors are described. The characteristics of the stress strain diagrams, up to incipient rupture, for mixtures of a standard clay with 20 to 40 per cent grog in 10 per cent proportions up to 60 per cent were investigated. The data confirm previous findings as to the nature of the diagrams. Further data were obtained to show the effect, in 30 per cent concentration, of non-plastics ranging in particle size from approximately 0.016 to 1.42 millimeters.

The data suggest that plasticity numbers derived by Atterberg's or similar methods give results which are affected to an important extent by the arbitrarily chosen limits, and that such numbers probably confuse the workability with the minimum moisture content at which plasticity is developed. It was shown that both the workability, **P**, and the minimum moisture content, M_0, for the development of plastic properties, decrease regularly with increasing grog content, and that the workability with the finest non-plastic additions tends to decrease in direct proportion to the clay content.

On the other hand, the workability is decreased at a considerably greater rate with coarser non-plastic (ordinary grog sizes). The decrease in minimum moisture content for workability is approximately proportional to the clay content for mixtures up to 40 per cent grog, after which it decreases more slowly. A comparison of this curve with the corresponding points at which shrinkage ceases in drying shows that in this case plasticity ceases at a higher moisture content than does shrinkage, and, consequently, a danger zone for drying exists. The two curves, however, approach one another and are coincident at 60 per cent grog, which is also the point of maximum dry density for these clay grog mixtures.

Experimental Structural Engineering, H. W. Coultas (Structural Engineering, 8 (1930), No. 8, pp. 290-301, figs. 6; abs. in [Gr. Brit.] Dept. Sci. and Indus. Research, Bldg. Sci. Abs., n. ser., 3 (1930), No. 10, p. 369).—The author discusses the use of small-scale models for determining the relative displacements of portions of a structure as a basis for the calculation of bending moments, shear forces and reactions without the labor of solving numerous and sometimes complex equations. A survey of accepted theories of stress analysis is followed by a numerical example illustrating the relation between analytical and mechanical methods of solution, and by an illustrated description of the principles, construction, and use of the Begg's deformeter.

Material and Structures, Vol. I, E. H. Salmon (London and New York: Longmans, Green & Co., 1931, vol. 1, pp. X + 638, pl. 1, figs. 395).—This first volume deals with the elasticity and strength of materials of construction.

Part 1 deals with elastic stresses and strains and contains chapters on stress, strain, and elasticity; complex stress and strain and thick cylinders; beams and bending; stresses due to bending; deflection of beams; beams fixed in direction and continuous beams; bending (continued), shear stress in beams, nonuniplanar bending, beams with initial curvature, and inclined beams; combined bending and direct stress, columns and struts, and long compression members; torsion and springs; strain energy—resilience; elastic vibrations and critical speeds; introduction to the mathematical theory of elasticity; and some applications of the methematical theory of elasticity.

Part 2 deals with the properties of materials of construction as determined by experiment and contains chapters on engineering materials and their properties, ferrous metals and alloys, and nonferrous metals and alloys; tension, compression, shear, torsion and acceptance tests; combined stresses and stress distribution and concentration; impact tests and hardness testing; repetition of stress—fatigue; properties of materials at high and low temperatures; and introduction to the study of metallography.

Drying of Exterior Paints Under Various Weather Conditions and Over Different Woods, F. C. Schmutz and F. C. Palmer (Industrial and Engineering Chemistry (Washington, D. C.), 22 (1930), No. 1, pp. 84-87, figs. 3; abs. in [Gr. Brit.] Dept. Sci. and Indus., Research, Bldg. Sci. Abs., n. ser., 3 (1930), No. 1, pp. 23, 24).—A laboratory study, conducted solely from the physical aspect, of the factors influencing the rate of drying and the subsequent durability of paint films is reported.

A description is given of the apparatus and technic used to simulate various atmospheric conditions of temperature, humidity and sunlight. Five typical house paints were used, covering a wide range in pigment and vehicle composition. These were applied to glass sheets, and the effects on drying time of thickness of film, humidity, light and temperature were determined.

The results obtained indicate that excessive humidity and low temperature contribute to delay in drying and to resultant weakness in paint film. Similar tests were carried out with paint films applied to wood disks, and it was found that the harmful effects of high humidities and low temperatures are intensified when poor quality woods are used.

Cleavage Tests of Timber, E. G. Coker and G. P. Coleman (Royal Society [London], Proceedings, Ser. A, 128 (1930), No. 808A, pp. 418-431, figs. 10; abs. in Sci. Abs., Sect. A—Phys., 34 (1931), No. 398, p. 84).—Cleavage is critically studied and discussed by reference to photoelastic tests carried out with isotropic material, particular attention being paid to the effect of the geometry of the specimen upon the results. It was found that fairly comparable results in cleavage tests can be expected only when one form is adhered to, and a numerical value of cleavage property calculated from the load at fracture, and the assumption of stress conditions derived from isotropic models can at best afford only an approximate value of this property. It is thought better to rely on a simple tension test to define cleavage property, the load being applied uniformly and normally to the grain of the timber.

Soil Mechanics Research, G. Gilboy (American Society of Civil Engineers (New York) Proceedings, 57 (1931), No. 8, pp. 1165-1188, figs. 13).—In a contribution from the Massachusetts Institute of Technology the salient features of the research conducted at that institution in the field of soil mechanics are summarized. The problems described fall into two main groups, namely, (1) soil physics, comprising studies of the composition and grain distribution of soils, permeability, compressibility, consolidation, compressive strength, internal friction, and cohesion; and (2) soil engineering, including investigations on the bearing capacity and settlement of foundations, on hydraulic-fill dams, and on the lateral pressure of earth against retaining walls.

The first group includes studies of the physical properties of soils and of the interrelation between these properties, with the ultimate object of understanding the nature of the effects observed in soils under various conditions. The second group comprises investigations of the behavior of soil as an engineering material forming part of a structure. It is pointed out that the two groups are closely interrelated, inasmuch as the knowledge of the behavior of a soil mass connotes a knowledge of the physical properties of its component parts.

In summarizing the work of others bearing on the subject, it is significant that no notice is taken of the comprehensive work which has been in progress at the Alabama Experiment Station on the subject for several years.

[Agricultural Engineering Investigations at the Illinois Station] (Illinois Station (Urbana) Report 1931, pp. 195-220, figs. 5). —Data are reported by E. W. Lehmann and A. L. Young relating to the amounts of electric energy used in different farm operations and the variation in the total energy used on a farm over a period of time. These show that the lighting circuit load is fairly low in summer and increases to its highest point during the winter months. The consumption by 7 electric ranges varied from 893 kilowatt-hours in July to 171 kilowatt-hours in November. The consumption of 4 refrigerators varied from 440 kilowatt-hours in July to 82 kilowatt-hours in December. The energy consumption of 2 milking machines was fairly constant throughout the year, varying from 50 to 67 kilowatt-hours a month. Five brooders were used during March, April and May, with the high consumption in April.

Further studies by Lehmann, in cooperation with A. M. Buswell of the Illinois State Water Survey, of sewage disposal for farms and isolated homes, with particular reference to the rate of sludge accumulation over a period of years, showed that there was no uniformity in the rate of sludge accumulation in three experimental septic tanks over a period of three years. There was a decrease in volume of sludge in all three tanks during the third year.

Studies of crankcase oils, by R. I. Shawl, when used in a kerosene tractor, indicated that these lubricants are constantly being improved. Studies of crankcase oil temperatures showed that these varied from 150 to 160 degrees (Fahrenheit) during April and May and from 160 to 175 degrees during June, July and August. The kind of farm work being done did not make much difference in the temperature of the oil.

In experiments on plowing for corn borer control, Young, in cooperation with R. B. Gray of the U.S.D.A. Bureau of Agricultural Engineering, found that standing stalks were somewhat easier to plow under in machine-picked fields than in hand-picked ones. Also, disked stalks were more easily covered than standing stalks. Where the stalks were not disked ahead of plowing, extra rolling coulters to cut the stalks into shorter pieces promoted better covering. Extremely mellow soil sometimes made it harder to cover trash, particularly when the plows were pulled at low speeds. Knives on stalk shavers must be kept sharp.

In most cases the plows did not cover trash as well when pulled slowly as when pulled faster. Hinged rear trash shields made of heavy sheet metal were effective in a machine-picked field in pushing down into the open furrow stray stalks that escaped from the wires or were lifted by the jointers. In a hand-picked field they clogged badly. In an effort to prevent this clogging, drums that would roll up over bunches of trash were substituted for these shields. Extra coulters, mounted so they would cut the trash somewhere near the center of the furrow slice, helped considerably when plowing under standing stalks. To some extent their use took the place of disking ahead of plowing.

Comparative data on the harvesting of wheat, oats and soybeans are reported by Young, Lehmann and Shawl, with particular reference to grain losses, and on hand and mechanical husking of corn. These show higher percentage losses for wheat than for oats by both combining and harvesting and threshing. It is apparent, however, that if only a reasonable acreage of oats is combined the losses need be no higher than for other crops. In the corn husking the losses from machine picking averaged 12.6 per cent and from hand picking 6.7 per cent. There is every reason to believe that losses in mechanical husking increase rapidly as the corn becomes riper and drier.

In the artificial drying studies with corn, Lehmann, R. H. Reed, W. L. Burlison and G. H. Dungan found in tests with the Carrier air-conditioning apparatus that drying at 130 degrees (Fahrenheit) cut germination more than drying at 110 degrees, the injury being greatest at high humidity. With a relative humidity of 5 per cent and a drying temperature of 130 degrees there was no reduction in percentage germination, but there was a marked decrease in the vigor of seedlings.

In the hay-drying tests it was found that crushing of alfalfa and soybean plants increased the rapidity of drying. Disease tests made by B. Koehler showed that while the Diplodia and Penicillium organisms had not been injured, 90 per cent of the **Fusarium moniliforme** had been killed by the artificial drying.

Data also are reported on terracing methods, the design of stationary spray plants for orchards, and on the planning of hog and poultry shelters.

A Comparative Study of Alcohol, Gasoline, and Kerosene, as Fuels for Tractor Engines, A. L. Teodoro (Philippine Agriculture (Los Banos) 20 (1931), No. 5, pp. 295-327, figs. 10).—Studies conducted at the New York Cornell Experiment Station on the comparative values of alcohol, gasoline and kerosene for tractor engines are reported. The studies involved 157 tests. Straight alcohol of different percentages and diluted and undiluted denatured alcohol were used instead of motor alcohol fuels which are of different compostiions. No attempt was made to increase the heating value of the fuel by the addition of ether, gasoline, or kerosene. The engines used were of commercial tractor types and included 2 rated at 15 to 30 horsepower, 1 rated at 15 to 25 horsepower, and 1 rated at 10 to 20 horsepower.

The dynamometer used was of the hydraulic type and could absorb a maximum of 150 horsepower at from 1,200 to 4,000 revolutions per minute. Observations were made of temperatures of all controlling factors, fuel consumption, and brake thermal efficiencies.

Water injection was found beneficial in tractors of the McCormick-Deering type when either gasoline or kerosene was used. The consumption was very much reduced from beginning half load to as high as the engine could develop. Injection of water increased the volumetric efficiency and lowered the radiator temperature at these loads. The maximum power developed was increased and knocking due to overheating of the engine was minimized. More injection water was consumed per brake-horsepower-hour when using gasoline than when using kerosene. The use of injection water is recommended for Cletrac "K" and Fordson types from about half load to normal capacity using gasoline and kerosene.

Book Review

"The Surplus Farmer," is the current agricultural problem, in the viewpoint of Bernhard Ostrolenk economist, College of the City of New York, presented in this, the first of a series of small books on contemporary economic problems edited by Paul T. Homan of Cornell University. How this "surplus farmer" came into being, who he is, his effect on markets, and what might be done about him are explained in chapters on The Era of Land Development, The Agricultural Revolution, The Agricultural Surplus, The Agricultural Export Trend, A Practical Lesson in Farm Relief, and Problems in Agricultural Readjustments Those who would like to know more about agricultural economics, and either pore or refuse to pore over the many verbose and weighty volumes on the subject, will find this presentation by Dr. Ostrolenk refreshing in viewpoint, clarity and brevity. Cloth, 5x7¼ inches, XVII + 135 pages. Harper and Brothers. $1.50.

"Farm Tractors," by Archie A. Stone, professor of farm mechanics, New York State Institute of Applied Agriculture, is a new text and reference on the subject, written especially to meet the needs of students in this field and of owners and operators. Its contents are divided into parts and chapters as follows: Part I — Construction, chapters — Development of Farm Tractors, The Tractor Factory, Tractor Engines, Fuel Systems and Carburetors, Magnetos and Ignition, Cooling Systems, Lubrications, Clutches, Transmission of Power and Front Axle, Front Wheels and Steering Gear; Part II — Operation, chapters — Operating Jobs and Adjustments, Operating Troubles, Loading the Tractor, Belt Work and Special Equipment; Part III — Repairing, chapters — Repairs and Supplies — Repairing Engine Shafts and Bearings, Repairing Cylinders, Pistons and Wrist Pins, Valve Timing, Repairing Valves and Replacing Gaskets, Repair of Transmission System, Clutch Repair, and Repair of Front Wheels, Front Axles, and Steering Gear. Cloth, 5¼x8 inches, 492 pages, 357 figures. John Wiley and Sons, Inc. $3.75.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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Raymond Olney, Editor

R. A. Palmer, Associate Editor

Drainage and Overproduction

THAT "drainage" covers two separate and distinct types of economic and social development was reemphasized at the recent National Drainage, Conservation and Flood Control Congress.

One is the exercise or exploitation of real or imagined new opportunities. It extracts the surplus water from large marshes and bogs, inocculates them with settlers, and hopes that the resulting productivity will justify the investment.

The other is for the individual already committed to farming, to a particular community and probably to a particular farm, by experience, abilities, preferences, hopes, home ties, activities in progress, frozen investments and other social and economic frictions which prevent him from answering calls to new and different opportunities. It helps him to make the best of a situation which he is in no position to change; to adapt his farming to the latest knowledge of crop requirements, efficient production equipment, and the market demand for high quality at low cost.

Sentiment at the Congress seemed to favor the drainage of established farms under present conditions and to discourage for the present any reclamation of new lands by drainage, according to L. A. Jones, chief of the division of drainage and soil erosion control, U.S.D.A. Bureau of Agricultural Engineering. In a paper on "Present Needs in Drainage Work" presented to the Congress, he explained and supported this viewpoint as follows:

> In the field of drainage, we should recognize that at the present time there is an apparent overproduction of agricultural products; that we have more land under cultivation than is necessary or advisable under existing conditions. It therefore seems logical that those really interested in the welfare of agriculture should oppose the undertaking of drainage improvements that will bring additional land under the plow at this time. There is no logical reason for advocating such development until the need for it is seen.
>
> This, however, does not mean that there is at present no need for drainage work. We are all acquainted with farms having pot holes or sloughs that divide them into irregular fields difficult to farm to the best advantage. In many instances entire fields are poorly or only partially drained—fields upon which the farmer expends each year as much labor, seed and fertilizer as he does upon his well-drained land, but on which the crop returns are generally limited and frequently fail completely. The cost of farming this poorly drained land is just as great, and frequently is greater, than the cost of farming well-drained land, while the limited crop yield obtained materially increases the average cost of production for the farm.
>
> The American farmer is confronted with world competition as never before. He must, by every means possible, lower his costs of production if he is to meet this competition and still maintain a standard of living comparable to that enjoyed by those engaged in other lines of industry. It seems desirable therefore to call to his attention the advantages to be gained from thorough drainage of the land upon which he is earning his living and to advocate that needed drainage improvements be made even under present depressed conditions. Many farmers realize the importance of good drainage and are making arrangements for improving their holdings. It has been reported to me that there has actually been an increase in the amount of drain tile sold in northwestern Ohio during the past year, and I feel certain that drainage work will increase materially, especially if the next season should prove to be a wet one, and thus offset to some extent the effect of the drought of the past two years.
>
> The attitude of the insurance companies that have acquired farm lands through foreclosure is interesting. Generally, one of their first steps is to examine such land and make arrangements for constructing any drainage improvements that may be necessary to put the land in the best shape for profitable cultivation. They realize that poorly drained land cannot compete on a paying basis with well-drained land.

This reasoning, as to what is and what is not now timely in drainage work, is commended to the consideration of all agricultural engineers, and through their educational influence, to such persons as urge that all drainage activities be discontinued for the time being.

Farm Building Plan Service

EVERYONE familiar with the farm structures field is aware that there is as yet no public, semi-public or private agency organized to give farmers adequate individual consulting service on their farm building problems, at a cost which is reasonable in proportion to the cost of the buildings involved.

J. L. Strahan and W. D. Brinckloe, prominent members of the A.S.A.E. Structures Division, have been working for some time on the problem of making such service available. Mr. Strahan has recently submitted his suggestions in the form of a preliminary prospectus for an organization which would, in brief, offer a low-cost stock plan and information service supplemented by individual service as necessary to solve any particular problem. He shows that the field of opportunity is large; that the proposed organization would not compete with professional architects, and that it would relieve extension departments, trade associations and manufacturers of the necessity of offering services they are now forced to offer.

Mr. Strahan seeks for his plan, or any improvement on it, the moral support of the American Institute of Architects, the American Society of Agricultural Engineers, and national farm organizations; and from the building materials and equipment industries financial support sufficient to start the project and carry it up to a self-supporting stage.

Details of the project are being worked out and are expected to be ready to submit to consideration by the Structures Division during or before the A.S.A.E. annual meeting at Columbus, Ohio, June 20 to 23. Meanwhile the principles and considerations involved are something to be thinking about.

Why Washington Was an Engineer

IN THE February AGRICULTURAL ENGINEERING appeared an article by Mr. M. A. R. Kelley, entitled "George Washington—America's First Agricultural Engineer." Since then Mr. E. W. Lehmann[1] has contributed a viewpoint on why Washington was an engineer which is worth additional consideration.

Washington was an engineer not because he was a surveyor, nor because of his other achievements in what are now recognized as engineering fields, but because he habitually thought and approached his problems as an engineer.

[1]Head of the department of agricultural engineering, University of Illinois. Mem. A.S.A.E.

He was more interested in the solution of problems than in the invention of machines. According to Mr. Lehmann, "His aims and objectives are in perfect accord with those of the modern agricultural engineer which are in brief 'to increase the productive capacity of the farm worker and to assist him in applying the income from the surplus produced for those things which contribute to the general well-being of rural life.'"

As in Washington's day, so today the distinguishing marks of the engineer, his greatest personal achievements, the means to his material achievements, are his thoughts.

Attitudes on Engineering and Social Progress

TO CHECK UP on a growing demand "that engineers be trained to understand and appreciate the social and economic implications of their work," Professors F. C. Caldwell, C. A. Norman, and John Younger, of the engineering college at Ohio State University, sought the opinions of leading industrialists and theoretical economists.

By questionnaire they obtained information and viewpoints from 97 executives, most of whom were either president or chairman of the board, of companies having annual sales in excess of $10,000,000, and employing many engineers; and from 33 economists on a list furnished by a professor of economics. Their analysis and report of these replies[1] is of some apparent interest and significance to agricultural engineers.

While no unanimous or near-unanimous answers to any of the questions were received, the relative favor and disfavor expressed, with or without qualifications, toward certain viewpoints, is worth noting and perhaps justifies some conclusions.

Of fifteen questions, the first thirteen dealt with such questions of modern social ethics and applied economics as the systematization of industry to meet the needs of the people at all times, human relief during depression, relation of production to consumption, income necessary to maintain a normal American standard of living, possibilities and methods of bringing this income within the reach of the masses, government ownership and operation of industries, voluntary national coordination of industries, maximum possible average income per worker, home owning for industrial employees, credit facilities, working periods, labor union cooperation in increasing efficiency and stabilization of industry, old-age pensions, importance of export trade, wage policy of foreign branch plants of American enterprises, and overstimulation of buying.

From the answers to the first question the authors tentatively concluded, and we believe this conclusion is justified by the answers given to the subsequent questions, that "engineering teachers should have no hesitation whatever in habituating their students to look at their technical tasks in a broadly social way."

Questions fourteen and fifteen applied specifically to engineering education. Of the industrial group, 53 indicated that a greater number of employees with technical college training are needed in their industries. One more held this viewpoint conditionally, while 38 were of the opposite opinion. The idea that technical college training should be restricted to persons showing pronounced technical talent was supported by 53 and opposed by 33, plus one conditionally. Opinion as to whether people should be helped to slip into their proper groove in industry with the minimum of technical training actually needed for the job totaled 46 for, one conditionally for and 30 against, in the industrial group. Economists' replies included only 2 conditionally for and 17 against the proposition.

A majority of 81 to 4 industrial leaders favored more cultural training and a wider social outlook for industrial executives. There were 5 more who felt it was "not needed but helpful."

Subjects desirable in engineering curricula, in addition to the strictly technical ones, as most frequently suggested by the industrialists are economics, history, English, psychology, public speaking, business administration and accounting. The economists' replies to the same question favored economics, history, psychology, political science, social science and accounting, in the order named. In all, 85 different subjects were named by one or more individuals answering this question.

In explaining their viewpoints the engineers making the study point out that "Engineers more than other people are expected to get results with a great measure of certainty"; that the profession has demonstrated its ability to overcome defects in industrial organization and managerial practice; and that under the pressure of present circumstances there is a growing demand that engineering direct its attention in a broader way to improvement in the whole capitalistic system of society, which its developments have so extensively modified.

This general relationship of engineering to social progress, and its implied obligations, seem also to apply specifically to agricultural engineering and agricultural progress. It is something for each agricultural engineering student and each agricultural engineer to consider in planning his further development and activities in the profession.

[1]"Economic Attitudes in Industry" Ohio Engineering Experiment Station Circular No. 26.

Current Viewpoints on Agriculture

A RECENT editorial in the daily press suggests that the greater part of agricultural deflation has already been recognized and written off; that young farmers are taking over at lower rents and valuations the places vacated by victims of surplus, deflation and changing methods; that agriculture is now more nearly ready for renewed prosperity than any other industry; and that there is some hope for the development of a national agricultural policy which will avoid a repetition of the history of the past decade.

This is good news so far as it may be true. The change of personnel and the casting off of old financial handicaps will no doubt hasten the farm application of engineering methods and equipment. These new farmers may be expected to produce more economically than their predecessors.

Some other writers, however, are not so optimistic about the readiness of agriculture for renewed prosperity. They point out that fewer farmers, with the aid of scientific advancement, mechanical power and equipment are producing more, at lower cost, and that progress in this direction has only begun. At the same time our export market for farm products, even at present prices, is rapidly diminishing. The diminishing market; the opportunity for and rate of progress in efficiency of farm production; the difficulties of adjustment for many marginal producers; the surplus of labor in urban industries; and the old ideals and traditions of agriculture suggest that there is still much difficult readjustment ahead of it.

It has been suggested that instead of a high-price stabilization which will encourage competition and uneconomic production, agriculture needs a low-price stabilization which will encourage readjustment by making the competition of inefficient producers, even at low standards of living, impossible. The low price would be made possible by economic, engineered production. In addition to discouraging peasant farming this would lower the cost of urban living and thereby create opportunities in urban industry for the farmers displaced.

The smallness or greatness of organizational changes necessary to put agriculture on its feet will influence agricultural engineering in detail rather than in principle. Conservative farmers, working toward lower production costs through numerous small steps and minor changes in their methods and equipment, will look to agricultural engineers to advise them and to work on their particular problems. So will extreme progressives testing daring new organization and production schemes. Their demands upon agricultural engineers will be as widely varying as their policies; their objectives identical—to keep well below the lowering margin of production cost.

A.S.A.E. and Related Activities

College Division Committee Meets in Washington

AT THE meeting of the Advisory Committee of the College Division of the American Society of Agricultural Engineers, at Washington, D. C., March 9-11, the committee adopted a resolution favoring analysis of research projects by the Office of Experiment Stations, U. S. Department of Agriculture, and voted to forward to the annual meeting of the Society in June a resolution endorsing the establishment of agricultural engineering extension projects in states in which such projects do not now exist. Members discussed the relation between college and commercial extension work and reaffirmed the position of the Committee on loans of machinery for education and demonstration as stated in a resolution adopted at the March meeting of 1926. Sessions were held in the quarters of the U. S. Bureau of Agricultural Engineering.

The work of the College Division was discussed in all its angles, including agricultural engineering teaching methods; coordination of research work; adoption of a national extension work program; establishment of publication standards for scientific articles to increase the output of meritorious material and to utilize channels of scientific publication; increased enrollment in graduate work; induction of agricultural engineers into industries; development of relation of agricultural engineering to agricultural products and their processing for utilization; and a national exhibit showing progress in development of agricultural machinery.

Much interest was manifest in the research workers' conference and in the extension conference scheduled to precede the A.S.A.E. annual meeting in Columbus, Ohio.

Members of the committee who attended the meeting included C. E. Seitz, chairman, G. W. McCuen, E. R. Gross and S. P. Lyle. The two other members, D. G. Carter and E. E. Brackett, were unable to attend but forwarded their reports. Others present at one or more sessions were President L. J. Fletcher, R. W. Trullinger, R. W. Carpenter and G. W. Kable, as well as S. H. McCrory, and other members of the Bureau of Agricultural Engineering.

A luncheon at the Cosmos Club in honor of President Fletcher and Chas. E. Seitz was attended by twenty-six agricultural engineers. Dr. Elwood Mead, commissioner of reclamation, Department of the Interior, presided.

After the last session of the meeting, some of the members of the Committee made an inspection of the laboratory of the National Rural Electric Project at College Park, Md., and of three of the cooperating experiment farms.

Architects to Consider Cooperation in Farm Structures Service

IN A recent letter to James L. Strahan, agricultural engineer prominent in A.S.A.E., Robert D. Kohn, president of the American Institute of Architects, practically assured consideration by that body at its convention April 27 to 29, of a proposed new farm building plan service.

Mr. Strahan and William Draper Brinckloe, architect and member of A.S.A.E., are authors of the proposal to make available for the first time a consulting service of professional character and fully qualified to help farmers solve their individual building problems at a cost consistent with the actual building costs involved. They anticipate that, in spite of the strong indications of the need and opportunity for such service which they have pointed out, strong backing will be necessary to gain acceptance for it and put it on a self-supporting basis.

Mr. Kohn indicated that the program for the coming convention of the AIA provides for "two sessions covering an entire afternoon and evening devoted to certain newer aspects of architectural practice," and that he had suggested consideration of the farm building service proposal some time during one of these sessions.

The Structures Division of A.S.A.E. has previously given the proposal some consideration and will probably give it more attention during the annual meeting of the Society at Columbus in June. Some of its representative members will probably be asked soon to study the proposal in detail and give their personal reactions and suggestions to it, so that the A.I.A. may know the extent to which structures men in the A.S.A.E. approve the plan.

New ASAE Members

F. Leslie Foss, assistant manager, Greenfield Electric Light & Power Co., Greenfield, Mass.

A. H. Hemker, rural electrification specialist, General Electric Co., 230 S. Clark St., Chicago, Ill.

Transfer of Grade

Arthur W. Clyde, associate professor of agricultural engineering, Pennsylvania State College, State College, Pa. (Associate to Member)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the March issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Elmer O. Anderson, associate professor of dairy industry, Connecticut Agricultural College, Storrs, Conn.

E. J. Hergenroether, metallurgist, The International Nickel Company, Inc., 4-117 General Motors Building, Detroit, Mich.

Hugh C. E. Peterson, agricultural engineer to the government of Bengal, Dacca, India.

Herbert J. Rath, secretary and assistant agricultural engineer on field work, Michigan State College, 2001 Teel Street, Lansing, Mich.

John W. Weaver, Jr., rural service engineer, Eastern Shore Public Service Company, Salisbury, Md.

G. E. Wenzloff, superintendent for Hickman Price, Lawrence Park West, Bronxville, N. Y.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER with more than 12 years experience in sale and advertising of farm equipment. Has had very close contact with the manufacturers of farm machinery as well as with the farming public through connection with the largest farm magazine publisher in the United States. Has also had experience in teaching and extension work in agricultural engineering. Qualifies admirably as publicity or public relations man as well as for selling or advertising. Available now. Age 36. Married. MA-211.